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The United States Strategic Bombing Surveys

(European War)
(Pacific War)

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Presented by
MajGen Matthew P. Caulfield

THE UNITED STATES STRATEGIC BOMBING SURVEYS

(European War)
(Pacific War)

Reprinted by
Air University Press
Maxwell Air Force Base, Alabama 36112-5532

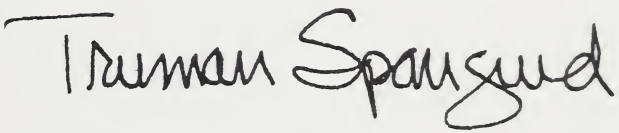
October 1987

FOREWORD

This volume contains an identical reprint of the Summary Reports (Europe and the Pacific) of the strategic bombing surveys conducted as World War II was coming to a close. Although originally published over four decades ago, they contain valuable lessons for modern airmen and is well worth another look.

The ''Blue Ribbon'' Strategic Bombing Survey Team was tasked to enter those areas struck by our strategic bombers as soon as possible after the bombing to assess the effectiveness of the bombing effort and its contribution to the Allied victory. The result of each survey was a detailed, multivolume report that examines every aspect of the bombing campaigns.

The Summary Reports reprinted herein are essentially executive summaries of the entire study. The lessons for airmen are here, and there is much to be learned in these few pages about the successful employment of air power.



TRUMAN SPANGRUD
Lieutenant General, USAF
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Air University

THE UNITED STATES STRATEGIC BOMBING SURVEY

SUMMARY REPORT

(European War)

September 30, 1945

FOREWORD

The United States Strategic Bombing Survey was established by the Secretary of War on November 3, 1944, pursuant to a directive from the late President Roosevelt.

The officers of the Survey were:

Franklin D'Olier, *Chairman*
Henry C. Alexander, *Vice-Chairman*
George W. Ball
Harry L. Bowman
John K. Galbraith
Rensis Likert
Frank A. McNamee
Paul H. Nitze
Robert P. Russell
Fred Searls, Jr.
Theodore P. Wright, *Directors*
Charles C. Cabot, *Secretary*

The Table of Organization provided for 300 civilians, 350 officers and 500 enlisted men. The Survey operated from headquarters in London and established forward headquarters and regional headquarters in Germany immediately following the advance of the Allied armies.

It made a close examination and inspection of several hundred German plants, cities and areas, amassed volumes of statistical and documentary material, including top German government documents; and conducted interviews and interrogations of thousands of Germans, including virtually all of the surviving political and military leaders. Germany was scoured for its war records, which were found sometimes, but rarely, in places where

they ought to have been; sometimes in safe-deposit vaults, often in private houses, in barns, in caves; on one occasion, in a hen house and, on two occasions, in coffins. Targets in Russian-held territory were not available to the Survey.

Some two hundred detailed reports were made, including an Over-all Report, of which this is a summary. During the course of its work, the Survey rendered interim reports and submitted studies and suggestions in connection with the air operations against Japan.

While the European War was going on, it was necessary, in many cases, to follow closely behind the front; otherwise, vital records might have been irretrievably lost. Survey personnel suffered several casualties, including four killed.

The Survey is now studying the effects of the air attack upon Japan. When that study is completed further reports will be submitted to the Secretary of War and the Secretary of the Navy.

SUMMARY REPORT

The new relation of air power to strategy presents one of the distinguishing contrasts between this war and the last. Air power in the last war was in its infancy. The new role of three-dimensional warfare was even then foreseen by a few farsighted men, but planes were insufficient in quality and quantity to permit much more than occasional brilliant assistance to the ground forces.

Air power in the European phase of this war reached a stage of full adolescence, a stage marked by rapid development in planes, armament, equipment, tactics and concepts of strategic employment, and by an extraordinary increase in the effort allocated to it by all the major contestants. England devoted 40 to 50 percent of her war production to her air forces, Germany 40 percent, and the United States 35 percent.

Nevertheless, at the end of hostilities in Europe, weapons, tactics and strategy were still in a state of rapid development. Air power had not yet reached maturity and all conclusions drawn from experience in the European theatre must be considered subject to change. No one should assume that because certain things were effective or not effective, the same would be true under other circumstances and other conditions.

In the European war, Allied air power was called upon to play many roles—partner with the Navy over the sea lanes; partner with the Army in ground battle; partner with both on the invasion beaches; reconnaissance photographer for all; mover of troops and critical supplies; and attacker of the enemy's vital strength far behind the battle line.

In the attack by Allied air power, almost 2,700,000 tons of bombs were dropped, more than 1,440,000 bomber sorties and 2,680,000 fighter sorties were flown. The number of combat planes reached a peak of some 28,000 at the maximum 1,300,000 men

were in combat commands. The number of men lost in air action was 79,265 Americans and 79,281 British. More than 18,000 American and 22,000 British planes were lost or damaged beyond repair.

In the wake of these attacks there are great paths of destruction. In Germany, 3,600,000 dwelling units, approximately 20% of the total, were destroyed or heavily damaged. Survey estimates show some 300,000 civilians killed and 780,000 wounded. The number made homeless aggregates 7,500,000. The principal German cities have been largely reduced to hollow walls and piles of rubble. German industry is bruised and temporarily paralyzed. These are the scars across the face of the enemy, the preface to the victory that followed.

How air supremacy was achieved and the results which followed from its exploitation are the subject of this summary report. The use of air power cannot properly be considered, however, except in conjunction with the broad plans and strategy under which the war was conducted.

The German Strategic Plan

Interrogation of Hitler's surviving confidants and General Staff and Field Generals of the Wehrmacht confirms the view that prior to the winter of 1941 Hitler hoped to realize Germany's ascendancy over Europe, and possibly the world, largely by skilled strategy. Time and timing were the secret weapons in the German war plan that took shape after 1933. Hitler hoped to build Germany's strength more quickly than that of any potential opponent. By rapid mobilization of a powerful striking force, by exploiting the political and ideological strains that he conceived to exist in the rest of the world, and by overwhelming separately in lightning campaigns such of his enemies as chose to resist, he hoped to secure for Germany an invulnerable position in Europe and in the world.

Note: All RAF statistics are preliminary or tentative.

What Germany lacked in numbers of divisions, in raw materials and in basic industrial strength, it planned to compensate with highly trained ground units of great striking power. These were to be equipped and ready to march while Germany's enemies were merely preparing. Essential in this strategy was a technically well-developed air force in being. Emphasis was not placed upon the development of an air force that would destroy the sustaining resources of the enemy's economy. In the German plan it was anticipated that an enemy's entire country would be so quickly over-run that little concern need be had for industrial and war production that was merely potential. The air force was, primarily, an arm of the blitzkrieg.

The success of Hitler's strategy, until the battle of Britain, was complete; his more cautious advisers and generals still confess of their astonishment. And by common report of the surviving Nazi leaders even the setback over Britain was considered of minor importance. The attack on Russia was next on the calendar—the decision to make this attack was taken in the autumn of 1940—and this, according to plan, was to be a brief four months' adventure. There would be time thereafter, if necessary, to deal with Britain. By September 1941 Hitler was so confident that he had succeeded in Russia that he ordered large scale cut-backs in war production.

The German War Economy

Study of German war production data as well as interrogation of those who were in charge of rearmament at the time, leaves no doubt that until the defeat at Moscow German industry was incompletely mobilized and that in fact Germany did not forsee the need for full economic mobilization. German arms production during 1940 and 1941 was generally below that of Britain. When the full meaning of the reverses at Moscow became apparent the German leaders called for all-out production. The conquests of the previous years had greatly strengthened Germany's economy; with the exception of oil and rubber, supplies of virtually all the previously scarce imported materials were or had become

accessible. Great reserves of foreign labor only awaited voluntary or forced recruitment. The industrial plant of France, the Low Countries, Poland and Czechoslovakia had been added to that of Germany. After the defeat at Moscow early in 1942, armament production increased rapidly. However, such increase was more the result of improvements in industrial efficiency than of general economic mobilization. Studies of German manpower utilization show that throughout the war a great deal of German industry was on a single shift basis, relatively few German women (less than in the first war) were drawn into industry and the average work week was below British standards.

Germany's early commitment to the doctrine of the short war was a continuing handicap; neither plans nor state of mind were adjusted to the idea of a long war. Nearly all German sources agree that the hope for a quick victory lasted long after the short war became a long one. Germany's armament minister Albert Speer, who assumed office in early 1942, rationalized German war production and eliminated the worst inefficiencies in the previous controls. A threefold increase in armament production occurred under his direction but the increase cannot be considered a testament to the efficiency of dictatorship. Rather it suggests the degree of industrial undermobilization in the earlier years. An excellent case can be made that throughout the war top government management in Germany was not efficient.

> The Fuehrer could not stand the climate of Russia; he complained of constant headaches.
>
> Jodl, Chief of Staff of German
> High Command, to Survey Interrogators

Because the German economy through most of the war was substantially undermobilized, it was resilient under air attack. Civilian consumption was high during the early years of the war and inventories both in trade channels and consumers' possession were also high. These helped cushion the people of the German cities from the effects of bombing. Plant and machinery were

plentiful and incompletely used. Thus it was comparatively easy to substitute unused or partly used machinery for that which was destroyed. While there was constant pressure throughout for German manpower for the Wehrmacht, the industrial labor supply, as augmented by foreign labor, was sufficient to permit the diversion of large numbers to the repair of bomb damage or the clearance of debris with relatively small sacrifice of essential production.

The Allied Strategic Plan

In both the RAF and the United States Army Air Forces there were some who believed that air power could deliver the knockout blow against Germany, and force capitulation. This view, however, was not controlling in the overall Allied strategic plan. The dominant element in that plan was invasion of the Continent to occur in the spring of 1944. Plans called for establishing air superiority prior to the date of the invasion and the exploitation of such superiority in weakening the enemy's will and capacity to resist.

The development of the air forces opposing Germany was heavily influenced by the fact that victory was planned to come through invasion and land occupation. In the early years of the war, to be sure, the RAF had the independent mission of striking at German industrial centers in an effort to weaken the German people. However, the weight of the RAF effort, compared with tonnages later employed, was very small—16,000 tons in 1940 and 46,000 tons in 1941 compared with 676,000 tons in 1944. Soon after the United States entered the air war in 1942, replacements for the new (and still small) Eighth Air Force were diverted to support the North African invasion. During 1943, target selection for the Eighth Air Force and the Fifteenth Air Force (based on the Mediterranean) reckoned always with the fact that maximum contribution must be made to the invasion in the coming year. And the Ninth Air Force in Western Europe and the Twelfth Air Force in the Mediterranean were developed with the primary mission of

securing the sky in the theatre of combat and clearing the way for ground operations. In the spring and early summer of 1944, all air forces based on England were used to prepare the way for the invasion. It was not intended that the air attacks against Germany proper and the German economy would be a subordinate operation, but rather a part of a larger strategic plan—one that contemplated that the decision would come through the advance of ground armies rather than through air power alone.

Early Air Operations—City Area Raids

The pioneer in the air war against Germany was the RAF. The RAF experimented briefly in 1940 with daylight attacks on industrial targets in Germany but abandoned the effort when losses proved unbearably heavy. Thereafter, it attempted to find and attack such targets as oil, aluminum and aircraft plants at night. This effort too was abandoned; with available techniques it was not possible to locate the targets often enough. Then the RAF began its famous raids on German urban and industrial centers. On the night of May 30, 1942, it mounted its first "thousand plane" raid against Cologne and two nights later struck Essen with almost equal force. On three nights in late July and early August 1943 it struck Hamburg in perhaps the most devastating single city attack of the war—about one third of the houses of the city were destroyed and German estimates show 60,000 to 100,000 people killed. No subsequent city raid shook Germany as did that on Hamburg; documents show that German officials were thoroughly alarmed and there is some indication from interrogation of high officials that Hitler himself thought that further attacks of similar weight might force Germany out of the war. The RAF proceeded to destroy one major urban center after another. Except in the extreme eastern part of the Reich, there is no major city that does not bear the mark of these attacks. However, no subsequent attack had the shock effect of the Hamburg raid.

I reported for the first time orally to the Fuehrer that if these serial attacks continued, a rapid end of the war might be the consequence.

Speer to Survey Interrogators
on the Hamburg attacks

In the latter half of 1944, aided by new navigational techniques, the RAF returned with part of its force to an attack on industrial targets. These attacks were notably successful but it is with the attacks on urban areas that the RAF is most prominently identified.

The city attacks of the RAF prior to the autumn of 1944, did not substantially affect the course of German war production. German war production as a whole continued to increase. This in itself is not conclusive, but the Survey has made detailed analysis of the course of production and trade in 10 German cities that were attacked during this period and has made more general analyses in others. These show that while production received a moderate setback after a raid, it recovered substantially within a relatively few weeks. As a rule the industrial plants were located around the perimeter of German cities and characteristically these were relatively undamaged.

Commencing in the autumn of 1944, the tonnage dropped on city areas, plus spill-overs from attacks on transportation and other specific targets, mounted greatly. In the course of these raids, Germany's steel industry was knocked out, its electric power industry was substantially impaired and industry generally in the areas attacked was disorganized. There were so many forces making for the collapse of production during this period, however, that it is not possible separately to assess the effect of these later area raids on war production. There is no doubt, however, that they were significant.

The Survey has made extensive studies of the reaction of the German people to the air attack and especially to city raids. These studies were carefully designed to cover a complete cross section of the German people in western and southern Germany and to reflect with a minimum of bias their attitude and behavior during the raids. These studies show that the morale of the German people

deteriorated under aerial attack. The night raids were feared far more than daylight raids. The people lost faith in the prospect of victory, in their leaders and in the promises and propaganda to which they were subjected. Most of all, they wanted the war to end. They resorted increasingly to "black radio" listening, to circulation of rumor and fact in opposition to the Regime; and there was some increase in active political dissidence—in 1944 one German in every thousand was arrested for a political offense. If they had been at liberty to vote themselves out of the war, they would have done so well before the final surrender. In a determined police state, however, there is a wide difference between dissatisfaction and expressed opposition. Although examination of official records and those of individual plants shows that absenteeism increased and productivity diminished somewhat in the late stages of the war, by and large workers continued to work. However, dissatisfied they were with the war, the German people lacked either the will or the means to make their dissatisfaction evident.

The city area raids have left their mark on the German people as well as on their cities. Far more than any other military action that preceded the actual occupation of Germany itself, these attacks left the German people with a solid lesson in the disadvantages of war. It was a terrible lesson; conceivably that lesson, both in Germany and abroad, could be the most lasting single effect of the air war.

The First Daylight Operations

> When Pearl Harbor came, the Fuehrer and myself, of course, showed to the outside world a happy face, but we were not pleased.
>
> Ribbenthrop to Survey Interrogators

The U.S. Army Air Forces entered the European war with the firm view that specific industries and services were the most promising targets in the enemy economy, and they believed that if

these targets were to be hit accurately, the attacks had to be made in daylight. A word needs to be said on the problem of accuracy in attack. Before the war, the U.S. Army Air Forces had advanced bombing techniques to their highest level of development and had trained a limited number of crews to a high degree of precision in bombing under target range conditions, thus leading to the expressions "pin point" and "pickle barrel" bombing. However, it was not possible to approach such standards of accuracy under battle conditions imposed over Europe. Many limiting factors intervened; target obscuration by clouds, gof, smoke screens and industrial haze; enemy fighter opposition which necessitated defensive bombing formations, thus restricting freedom of maneuver; antiaircraft artillery defenses, demanding minimum time exposure of the attacking force in order to keep losses down; and finally, time limitations imposed on combat crew training after the war began.

It was considered that enemy opposition made formation flying and formation attack a necessary tactical and technical procedure. Bombing patterns resulted—only a portion of which could fall on small precision targets. The rest spilled over on adjacent plants, or built-up areas, or in open fields. Accuracy ranged from poor to excellent. When visual conditions were favorable and flak defenses were not intense, bombing results were at their best. Unfortunately, the major portion of bombing operations over Germany had to be conducted under weather and battle conditions that restricted bombing technique, and accuracy suffered accordingly. Conventionally the air forces designated as "the target area" a circle having a radius of 1000 feet around the aiming point of attack. While accuracy improved during the war, Survey studies show that, in the over-all, only about 20% of the bombs aimed at precision targets fell within this target area. A peak accuracy of 70% was reached for the month of February 1945. These are important facts for the reader to keep in mind, especially when considering the tonnages of bombs delivered by the air forces. Of necessity a far larger tonnage was carried than hit German installations.

Although the Eighth Air Force began operations August 17, 1942, with the bombing of marshalling yards at Rouen and Sotteville in northern France, no operations during 1942 or the first half of 1943 had significant effect. The force was small and its range limited. Much time in this period was devoted to training and testing the force under combat conditions.

In November and December 1942, the U-boat attack on Allied merchant shipping was in its most successful phase and submarine bases and pens and later construction yards became the chief target and remained so until June 1943. These attacks accomplished little. The submarine pens were protected and bombs did not penetrate the 12-foot concrete roofs. The attack on the construction yards and slipways was not heavy enough to be more than troublesome.

In January 1943, at Casablanca, the objective of the strategic air forces was established as the "destruction and dislocation of the German Military, industrial, and economic system and the undermining of the morale of the German people to the point where their capacity for armed resistance is fatally weakened." Specific target systems were named.

In the spring of 1943, Allied naval and air power scored a definite victory over German submarines. Surface craft teamed with long-range patrol bombers equipped with radar raised German submarine losses to catastrophic levels in the spring of 1943. Interrogation of members of the High Command of the German Navy, including Admiral Doenitz, has confirmed the scope of this victory. When the Combined Bomber Offensive Plan was issued in June of 1943 to implement the Casablanca directive, submarines were dropped from first priority and the German aircraft industry was substituted. The German ball-bearing industry, the supplier of an important component, was selected as a complementary target.

The Ball-Bearing Attack

The German anti-friction bearing industry was heavily concentrated. When the attack began, approximately half the

output came from plants in the vicinity of Schweinfurt. An adequate supply of bearings was correctly assumed to be indispensable for German war production.

In a series of raids beginning on August 17, 1943, about 12,000 tons of bombs were dropped on this target—about one-half of one per cent of the total tonnage delivered in the air war. In an attack on August 17 by 200 B–17's on Schweinfurt, the plants were severely damaged. Records of the industry taken by the Survey (and supplemented and checked by interrogation) show that production of bearings at this center was reduced sharply—September production was 35% of the pre-raid level. In this attack 36 of the 200 attacking planes were lost. In the famous and much discussed second attack on October 14, 1943, when the plants were again severely damaged, one of the decisive air battles of the war took place. The 228 bombers participating were strongly attacked by German fighters when beyond the range of their fighter escort. Losses to fighters and to flak cost the United States forces 62 planes with another 138 damaged in varying degree, some beyond repair. Repeated losses of this magnitude could not be sustained; deep penetrations without escort, of which this was among the earliest, were suspended and attacks on Schweinfurt were not renewed for four months. The Germans made good use of the breathing spell. A czar was appointed with unlimited priority for requisitioning men and materials. Energetic steps were taken to disperse the industry. Restoration was aided by the circumstances—which Survey investigations show to have been fairly common to all such raids—that machines and machine tools were damaged far less severely than factory structures. German equipment was redesigned to substitute other types of bearings wherever possible. And the Germans drew on the substantial stocks that were on hand. Although there were further attacks, production by the autumn of 1944 was back to pre-raid levels. From examination of the records and personalities and the testimony of war production officials, there is no evidence that the attacks on the ball-bearing industry had any measurable effect on essential war production.

The Attack on German Aircraft Plants

The heavy losses over Schweinfurt caused an important revision in the tactics of daylight bombing. Until then it had been believed that unescorted bombers, heavily gunned and flying in well designed formations, could penetrate this deeply over the Reich. At least, so far as a small force was concerned, this was proven wrong. For the remainder of 1943 after the Schweinfurt raids, daylight penetrations beyond fighter escort were sharply circumscribed. Meanwhile the U.S. heavy bomber force increased substantially in strength. In December of 1943, the P–51 (Mustang) long-range fighter first became available and in the early months of 1944 the numbers increased. With this plane, in some respects the most important addition to allied air power during the European war, augmenting the P–47 (Thunderbolt) escorts which in the meantime had materially increased their range, daylight operations in depth were again launched.

The attack on the German aircraft industry—primarily on airframe plants—was opened in the summer of 1943. The German aircraft industry had been well distributed over the Reich with a view to the possibility of air attack. Isolated raids early in 1941 and 1942 had caused some further shift in production to eastern territory but only limited steps had been taken to disperse individual plant units in order to reduce their vulnerability. The industry was found to have had substantial excess capacity. The efficiency of the industry was low. Unlike other armaments, procurement was not under the direction of the Speer Ministry but under the Luftwaffe.

Production in the early years of the war was small, primarily because Luftwaffe requirements were modest—in 1941 according to captured minutes of German staff conferences, General Jeschonnek, then chief of the air staff, opposed a suggested increase in fighter plane production with the remark that he wouldn't know what to do with a monthly production of more than 360 fighters. However, in the autumn of 1943 plans then current called for a steadily increasing output of fighters.

In the 1943 attacks, 5,092 tons were dropped on 14 plants, primarily on airframe plants. The records show that acceptance of the Me–109, Germany's standard single-engine fighter, dropped from 725 in July to 536 in September and to a low of 357 in December. Acceptance of Focke-Wulf 190's dropped from 325 in July to 203 in December. As a result of the attacks the Germans began a more vigorous program of subdividing and dispersing aircraft plants and this caused part of the reduction in production. A further but undetermined part was the result of poor weather which cut down acceptance flights; it is probable that some planes produced but not accepted during these months were added to acceptance figures in the months following. The Germans as a result of these attacks decided to place increased emphasis on the production of fighter planes.

The culminating attacks on the German aircraft industry began in the last week of February 1944. With the protection of long-range fighter escort, 3,636 tons of bombs were dropped on German aircraft plants (again, airframe rather than engine plants) during that week. In that and succeeding weeks every known aircraft plant in Germany was hit.

Detailed production data for this period, as far others, were taken by the Survey, and German air generals, production officials, and leading manufacturers, including Messerschmitt and Tank (of Focke-Wulf) were interrogated at length. Production was not knocked out for long. On the contrary, during the whole year of 1944 the German air force is reported to have accepted a total of 39,807 aircraft of all types—compared with 8,295 in 1939, or 15,596 in 1942 before the plants suffered any attack. Although it is difficult to determine exact production for any single month, acceptances were higher in March, the month after the heaviest attack, than they were in January, the month before. They continued to rise.

Part of the explanation was the excess capacity of the airframe industry which, as noted, was considerable. Excess capacity in airframes was considerably greater than in engines. Studies of individual plants by the Survey show that although buildings were

destroyed the machine tools showed remarkable durability. And the Germans showed capacity for improvising their way out. Immediately after the attacks, responsibility for production was shifted from the Luftwaffe to the Speer Ministry. A special staff was organized for the reconstitution and dispersal of the industry. This staff (the Jaegerstab or Fighter-Staff) appears to have done an effective job of mobilizing unused capacity and undamaged machines, reorganizing inefficient managements, reducing the number of types of planes and, most important of all, in subdividing production into small units that were comparatively immune from attack. It was aided by previous plans for expansion and it cut sharply into available inventories of parts. Although the testimony on the point is conflicting, the Jaegerstab may have sacrificed quality and an adequate complement of spare parts, for quantity production. Nevertheless the attack on the aircraft plants, like the attack on the ball-bearing plants, showed that to knock out a single industry with the weapons available in 1943 and early 1944 was a formidable enterprise demanding continuous attacks to effect complete results. Recovery was improvised almost as quickly as the plants were knocked out. With the shift in priority for strategic attacks—the first to marshalling yards, and bridges in France in preparation for invasion, immediately followed by the air campaign against oil—the continued attacks on the aircraft industry were suspended.

The Defeat of the German Air Force

The seeming paradox of the attack on the aircraft plants in that, although production recovered quickly, the German air force after the attacks was not again a serious threat to Allied air superiority. The attacks in the winter of 1944 were escorted by P–51's and P–47's and with the appearance of these planes in force a sharp change had been ordered in escort tactics. Previously the escort planes had to protect the bomber force as their primary responsibility. They were now instructed to invite opposition from

German fighter forces and to engage them at every opportunity. As a result, German fighter losses mounted sharply. The claimed losses in January were 1,115 German fighters, in February 1,118 and in March 1,217. The losses in planes were accompanied by losses in experienced pilots and disorganization and loss of the combat strength of squadrons and groups. By the spring of 1944 opposition of the Luftwaffe had ceased to be effective.

> I believe the Fuehrer was not very much elated at the loss of efficiency of our air forces.
>
> Kesselring to Survey Interrogators

German air generals responsible for operations in France stated under interrogation that on D-day the Luftwaffe had only 80 operational planes with which to oppose the invasion. At no time between D-day and the breakthrough at St. Lo did reinforcements offset losses and increase the size of this force.

German fighter production continued to increase during the summer of 1944, and acceptances reached a peak of 3,375 in September. Although it has studied the problem with considerable care, the Survey has no clear answer as to what happened to these planes; the differences of opinion between German air generals, it might be added, are at least as great between those who have searched for the explanation. Certainly only a minority of the planes appeared in combat. Possibly the remainder were lost in transit from factory to combat bases, destroyed on the fields, or grounded because of shortage of gasoline or pilots. Conceivably some are parts of an inflation of German production figures. The answer is not clear.

> The more I have been asked about these things, the clearer they become.
>
> Goering to Survey Interrogators

After September, German aircraft production declined gradually until December, when 3,155 planes were accepted, and in January

1945, because of the shortage of gasoline, production of all except jet types was virtually discontinued. The jet planes, especially the ME–262, were the most modern planes which any belligerent had in general operation at the end of the war. According to manufacturers and other competent observers, their production was delayed because of the failure of the Luftwaffe to recognize in time the advantages of the type. It was also delayed because Hitler intervened in 1944 with an ill-timed order to convert the ME-262 to a fighter-bomber. Virtually every manufacturer, production official, and air force general interrogated by the Survey, including Goering himself, claimed to have been appalled by this order. By May 1945, 1,400 jets had been produced. Had these planes been available six months earlier with good quality pilots, though they might not have altered the course of the war, they would have sharply increased the losses of the attacking forces.

> At every conversation with the Fuehrer I used to ask, "When will the Luftwaffe arrive?"
>
> Kesselring to Survey Interrogators

The Attack on Oil

With the reduction of German air power, oil became the priority target in the German economy. The bomber force for several months had been adequate for the task. A preliminary attack was launched on May 12, 1944, followed by another on May 28; the main blow was not struck, however, until after D-day. In the months before D-day and for a shorter period immediately following, all available air power based on England was devoted to insuring the success of the invasion.

Virtually complete records of the German oil industry were taken by the Survey. In addition, major plants that were subject to attack and their records were studied in detail.

The German oil supply was tight throughout the war, and was a controlling factor in military operations. The chief source of

supply, and the only source for aviation gasoline, was 13 synthetic plants together with a small production from three additional ones that started operations in 1944. The major sources of products refined from crude oil were the Ploesti oil fields in Rumania and the Hungarian fields which together accounted for about a quarter of the total supply of liquid fuels in 1943. In addition, there was a small but significant Austrian and domestic production. The refineries at Ploesti were attacked, beginning with a daring and costly low-level attack in August 1943. These had only limited effects; deliveries increased until April 1944 when the attacks were resumed. The 1944 attacks, together with mining of the Danube, materially reduced Rumanian deliveries. In August 1944, Russian occupation eliminated this source of supply and dependence on the synthetic plants became even greater than before.

Production from the synthetic plants declined steadily and by July 1944 every major plant had been hit. These plants were producing an average of 316,000 tons per month when the attacks began. Their production fell to 107,000 tons in June and 17,000 tons in September. Output of aviation gasoline from synthetic plants dropped from 175,000 tons in April to 30,000 tons in July and 5,000 tons in September. Production recovered somewhat in November and December, but for the rest of the year was but a fraction of pre-attack output.

The Germans viewed the attacks as catastrophic. In a series of letters to Hitler, among documents seized by the Survey, in developing crisis is outlined month by month in detail. On June 30, Speer wrote: ''The enemy has succeeded in increasing our losses of aviation gasoline up to 90 percent by June 22d. Only through speedy recovery of damaged plants has it been possible to regain partly some of the terrible losses.'' The tone of the letter that followed was similar.

As in the case of ball-bearings and aircraft, the Germans took the most energetic steps to repair and reconstruct the oil plants. Another czar was appointed, this time Edmund Geilenberg, and again an overriding priority on men and materials was issued.

Geilenberg used as many as 350,000 men for the repair, rebuilding, and dispersal of the bombed plants and for new underground construction. The synthetic oil plants were vast complex structures and they could not be easily broken up and dispersed. The programs of dispersal and underground construction that were undertaken were incomplete when the war ended.

The synthetic oil plants were brought back into partial production and in remarkably short time. But unlike the ball-bearing plants, as soon as they were brought back they were attacked again. The story of Leuna is illustrative. Leuna was the largest of the synthetic plants and protected by a highly effective smoke screen and the heaviest flak concentration in Europe. Air crews viewed a mission to Leuna as the most dangerous and difficult assignment of the air war. Leuna was hit on May 12 and put out of production. However, investigation of plant records and interrogation of Leuna's officials established that a force of several thousand men had it in partial operation in about 10 days. It was again hit on May 28 but resumed partial production on June 3 and reached 75 percent of capacity in early July. It was hit again on July 7 and again shut down but production started 2 days later and reached 53 percent of capacity on July 19. An attack on July 20 shut the plant down again but only for three days; by July 27 production was back to 35 percent of capacity. Attacks on July 28 and 29 closed the plant and further attacks on August 24, September 11, September 13, September 28 and October 7 kept it closed down. However, Leuna got started again on October 14 and although production was interrupted by a small raid on November 2, it reached 28 percent of capacity by November 20. Although there were 6 more heavy attacks in November and December (largely ineffective because of adverse weather), production was brought up to 15 percent of capacity in January and was maintained at that level until nearly the end of the war. From the first attack to the end, production at Leuna averaged 9 percent of capacity. There were 22 attacks on Leuna, 20 by the Eighth Air Force and 2 by the RAF. Due to the urgency of keeping this plant out of production, many of these missions were dispatched in difficult bombing weather. Consequently, the order

of bombing accuracy on Leuna was not high as compared with other targets. To win the battle with Leuna a total of 6,552 bomber sorties were flown against the plant, 18,328 tons of bombs were dropped and an entire year was required.

> Today we have finished rebuilding the plants and tomorrow the bombers will come again.
>
> Saying attributed to German workers engaged in rebuilding synthetic oil plants.

Consumption of oil exceeded production from May 1944 on. Accumulated stocks were rapidly used up, and in six months were practically exhausted. The loss of oil production was sharply felt by the armed forces. In August the final run-in-time for aircraft engines was cut from two hours to one-half hour. For lack of fuel, pilot training, previously cut down, was further curtailed. Through the summer, the movement of German Panzer Divisions in the field was hampered more and more seriously as a result of losses in combat and mounting transportation difficulties, together with the fall in fuel production. By December, according to Speer, the fuel shortage had reached catastrophic proportions. When the Germans launched their counter-offensive on December 16, 1944, their reserves of fuel were insufficient to support the operation. They counted on capturing Allied stocks. Failing in this, many panzer units were lost when they ran out of gasoline. In February and March of 1945 the Germans massed 1,200 tanks on the Baranov bridgehead at the Vistula to check the Russians. They were immobilized for lack of gasoline and overrun.

Further Dividends from the Oil Attack

The attack on the synthetic oil plants was also found to have cost Germany its synthetic nitrogen and methanol supply and a considerable part of its rubber supply.

Germany, like other industrial countries, relied on synthesis for its supply of nitrogen and the synthetic oil plants were by far the largest producers. Sixty percent of the nitrogen production and 40 percent of the methanol production came from two synthetic plants. Monthly output of synthetic nitrogen in early 1944, before the synthetic plants were attacked, was about 75,000 tons. It had been reduced by the end of the year to about 20,000 tons.

Nitrogen, besides being indispensable for explosives, is heavily used in German agriculture. Allocation for the 1943–44 crop year was 54 percent of the total supply; allocation for 1944–45 was first planned at 25 percent and later eliminated altogether. Nitrogen for munitions was maintained by reducing the allocation to agriculture, but by the end of 1944 this cushion has been substantially exhausted. The supply of explosives then declined with the reduction in supply of nitrogen. It became necessary to fill shells with a mixture of explosives and non-explosive rock salt extender. There was a general shortage of ammunition on all fronts at the end of the war. There was an equally serious shortage of flak ammunition; units manning flak guns were instructed not to fire on planes unless they were attacking the installations which the guns were specifically designated to protect and unless ''they were sure of hitting the planes!''

It is of some interest that a few weeks before the close of hostilities the Germans reallocated nitrogen to agriculture at the expense of ammunition. This was the result, according to Production Minister Speer, of an independent decision of his own that the war was lost and the next year's crop should be protected.

Methanol production, necessary among other things for TNT, hexogen and other high explosives, was as severely affected as nitrogen production. Allocations to the principal consumers was heavily cut, and eventually the production of hexogen was abandoned. The loss of methanol coupled with the reduction in nitrogen was followed by a precipitate decline in production of explosives.

The synthetic rubber industry also suffered from the attack on oil. Official German records on raw material supplies show that

stockpiles of rubber were small at the beginning of the war—at the most sufficient for only two or three months' consumption. Imports through the blockade were unimportant. The supply came from four synthetic plants, one of which was a small pilot plant; and two additional plants were under construction during the war. One of the major plants, located at Huels, was attacked as a primary target by the Eighth Air Force in June 1943 and closed for a month; it required three months to get back to 72 percent of capacity and seven months to get back to full production. However, it operated on gas from synthetic oil plants in the Ruhr; when these were knocked out in the summer of 1944, production was again reduced substantially. Production at Schkopau, the largest of the synthetic rubber plants, was lost because it was dependent on hydrogen from Leuna. Investigation of the two remaining plants revealed that production was largely eliminated because of attacks on oil plants of which they were a part. By the end of 1944 over-all statistics for the industry show that production of synthetic rubber had been reduced to 2,000 tons a month or about one-sixth the wartime peak. Had the war continued, Germany's rubber position would have become critical. No indication was found, however, that the rubber shortage had become a limiting factor of the German army before the war ended.

Except for oil and associated nitrogen, methanol, and rubber production, no parts of the German chemical industry were a priority target of the Combined Bomber Offensive.

Steel

By mid-1944 the air war had entered a new phase. Its most important feature, apart from mastery of the air, was the greatly increased weight of the attack that could be brought to bear; in the second half of 1944, 481,400 tons of bombs were dropped on Germany as compared with 150,700 in all 1943. The RAF and the United States Army Air Forces during this period were teamed in a

fully coordinated offensive and the RAF was returning to the attack of specific industrial targets. A target that was attacked with poor results in 1943 might have yielded major returns in 1944 for the simple reason that an attack in 1944 was certain to be enormously heavier. With improved bombing techniques it was also likely to be considerably more accurate. Increased weight was a major feature of the raids that reduced the German steel industry.

Germany began the war with approximately 23,000,000 metric tons per year of steel capacity, about 69 percent of which was in the Ruhr. The 1940 victories added another 17,000,000 tons principally in Lorraine, Belgium and Luxembourg. However, official records and those of the industry for the war years, supplemented by interrogation, show that the 40,000,000 tons theoretical capacity was never reached. Production in the occupied countries was always troublesome and deficient. In spite of the considerable efforts to develop low-grade ores in Germany proper and medium grade ores in Germany proper and medium grade ores in Austria, Germany throughout the war continued to be primarily dependent on Swedish, Norwegian and French ores.

Unlike the United States, Germany did not have to find steel to build a large merchant fleet or for a program of heavy naval construction. Nor did she have to build a complete munitions industry in the middle of the war. For these reasons the German steel supply for finished munitions was only slightly less liberal than that of the United States. Although steel was considered a bottleneck by the Germans, a detailed examination of the control machinery together with interrogation of officials in the Speer ministry and its predecessor organizations, reveals that the trouble was partly an inefficient allocation system and partly, in the early years of the war especially, an unwillingness to cut out nonessential construction and civilian consumption. German industrialists were also found to have had a marked propensity to hoard steel.

Throughout the war there was considerable debate whether the German steel industry was a desirable target—and especially whether steel mills were vulnerable to the type of attack that could be made. In 1943 the RAF made a modest attack on the steel

industry of the Ruhr but the attack was given up because it was believed to have been too costly for the results achieved. Production records taken by the Survey show, in fact, that it had some effect; production in the Ruhr declined by approximately 10 percent during the attack and did not fully recover during the remainder of the year. German steel producers were required by the government to keep records of production losses and their causes. These records show that air raid alerts in 1943 were a more serious cause of the lost production than the actual damage from the raids.

> The Fuehrer ordered that a news item in the 'New York Times' reporting that production in the Ruhr had been cut 50 percent by bombing be not contradicted. The Fuehrer said this was percisely the impression he wished to create.
>
> From secret minutes, taken by the Survey of meetings between Hitler and war production officials.

During the last half of 1944 both the cities and the transportation system of the Ruhr were the targets of extremely heavy attack, primarily by the RAF. Production of steel in the Ruhr was reduced by 80 percent between June and the end of the year. Loss of production of high-grade steel in the Ruhr was greater than the loss of Bessemer steel and high-grade steel became a bottleneck by the middle of 1944. German steel production for all the Reich and occupied countries declined from 2,570,000 metric tons in July to 1,000,000 metric tons in December. Of this loss about 490,000 tons was the result of loss of territory.

Examination of the steel plants showed that, although the attack damaged some blast furnaces, open hearths and rolling mills, it was primarily effective through damage to utilities (electricity, gas and water) and communications within the plants and to utilities and transport supplying the plants.

Although steel production had been reduced to critical levels by the end of 1944 and continued to fall until the end of the war, Survey studies do not indicate that the steel shortage (unlike the oil

shortage or even the ammunition shortage) was decisive. It might have been decisive if the war had continued, and if this specific shortage had not been overshadowed by the disintegration of the whole economy. As it developed at the end of the war, certain German industries had inventories of steel that ranged from comfortable to generous.

The Secondary Campaigns

During the course of the air war, and particularly during 1944 and 1945, a number of other German industries were attacked, some of them in force and others merely as secondary targets, or as targets of opportunity when the main objective could not be reached or found. The Survey has examined each of these industries. Individual plants and records were examined and analyzed in conjunction with over-all industry data which were also located.

> All these figures, the Fuehrer had in his head.
>
> Keitel, Chief of German High Command, to Survey Interrogators

Plants producing tanks and armored vehicles were attacked occasionally in 1943 and early 1944. They were attacked more strongly in August, September and October 1944 in an effort to provide direct support to ground operations. Between October 1943 and July 1944, the period of the first attacks, the industry produced 14,000 tanks and related vehicles. Analysis of production schedules suggests that these attacks cost the Germans several hundred units. By the time of the heavier attacks, production, especially production of engines and components, had been considerably expanded and dispersed. The effect again may have been to cause the industry to fall short of achievable production. Production dropped from 1,616 in August to 1,552 in September. However, it rose to 1,612 in October and to 1,770 in November, and reached its wartime peak in December 1944, when 1,854 tanks

and armored vehicles were produced. This industry continued to have relatively high production through February 1945.

In the last half of 1944 German truck production was attacked. Three plants produced most of Germany's truck supply. One of these, Opel at Brandenburg, was knocked out completely in one raid on August 6, 1944, and did not recover. Daimler Benz was similarly eliminated by attacks in September and October. Ford at Cologne, the third large producer, was not attacked but records show that production was sharply curtailed during the same period by destruction of component supplies and the bombing of its power supply. By December of 1944, production of trucks was only about 35 percent of the average for the first half of 1944.

In November of 1944, the Allied air forces returned to an attack on the submarine building yards. In the months that had elapsed since the spring of 1943, the Germans had put into production the new Types 21 and 23 designed to operate for long periods without surfacing and so escape radar equipped aircraft patrols as well as surface attack. And an ambitious effort had been made to prefabricate submarine hulls and turn the slipways into more points of final assembly. The program was not working smoothly. Though nearly two hundred had been produced, difficulties with the new type, together with the time required for training crews, had prevented all but eight from becoming operational. These delays cannot be attributed to the air attack.

The attacks during the late winter and early spring of 1945 did close, or all but close, five of the major yards, including the great Blehm and Voss plant at Hamburg. Had the war continued, these attacks, coupled with the attack on transportation, would have removed the threat of further production of the new submarine.

Many more German industries were hit—mostly in the course of the city attacks of the RAF, but some as secondary targets of daylight attacks, or in spill-overs from the primary target. Industries so attacked included optical plants, power plants, plants making electrical equipment, machine tool plants, and a large number of civilian industries. There were also special enterprises. The bombing of the launching sites being prepared for the V

weapons delayed the use of V-1 appreciably. The attacks on the V-weapon experimental station at Peenemunde, however, were not effective; V-1 was already in production near Kassel and V-a had also been moved to an underground plant. The breaking of the Mohne and the Eder dams, though the cost was small, also had limited effect. Certain of the attacks—as for example the Berlin raids that cost the Germans a good half of their clothing industry—caused the Germans manifest discomfort and may have delayed war production. Also, in the aggregate, they caused some diversion of resources from essential war production, although this effect was minimized by the substantial cushion in Germany's war economy until the closing months of the war.

The Attack on the Railways and Waterways

The attack on transportation was the decisive blow that completely disorganized the German economy. It reduced war production in all categories and made it difficult to move what was produced to the front. The attack also limited the tactical mobility of the German army.

The Survey made a careful examination of the German railway system, beginning as soon as substantial portions were in Allied hands. While certain important records were destroyed or lost during the battle of Germany, enough were located so that together with interrogation of many German railroad officials, it was possible to construct an accurate picture of the decline and collapse of the system.

Germany entered the war with an excellent railway system; it had generally overcapacity in both lines and yards (built partly in anticipation of military requirements), and, popular supposition to the contrary, the system was not undermaintained. Standards of maintenance were higher than those general in the United States. The railway system was supplemented by a strong inland waterways system connecting the important rivers of Northern Germany, crisscrossing the Ruhr and connecting it with Berlin. The waterways carried from 21 to 26 percent of the total freight

movement. Commercial highway transportation of freight was insignificant; it accounted for less than three percent of the total.

Although the investigation shows that the railroad system was under strain—especially during the winter campaign in Russia in 1941–42 when there was a serious shortage of cars and locomotives—it was generally adequate for the demands placed upon it until the spring of 1944. New construction and appropriation of equipment of occupied countries remedied the locomotive and car shortage. The Reichsbahn had taken no important steps to prepare itself for air attack.

The attack on German transportation was immediately woven with the development of ground operations. In support of the invasion a major assignment of the air forces had been the disruption of rail traffic between Germany and the French coast through bombing of marshalling yards in northern France. At the time of the invasion itself a systematic and large-scale attempt was made to interdict all traffic to the Normandy beachhead. These latter operations were notably successful; as the front moved to the German border the attack was extended to the railroads of the Reich proper. Heavy and medium bombers and fighters all participated.

Although prior to September 1944, there had been sporadic attacks on the German transportation system, no serious deterioration in its ability to handle traffic was identified by the Survey. The vastly heavier attacks in September and October 1944 on marshalling yards, bridges, lines, and on train movements, produced a serious disruption in traffic over all of western Germany. Freight car loadings, which were approximately 900,000 cars for the Reich as a whole in the week ending August 19 fell to 700,000 cars in the last week of October. There was some recovery in early November, but thereafter they declined erratically to 550,000 cars in the week ending December 23 and to 214,000 cars during the week ending March 3. Thereafter the disorganization was so great that no useful statistics were kept.

The German economy is heading for inevitable collapse within 4–8 weeks.

Report of Speer to Hitler
March 15, 1945

The attack on the waterways paralleled that on the railways; the investigation shows that it was even more successful. On September 23, 1944, the Dortmund-Ems and Mittelland canals were interdicted stopping all through water traffic between the Ruhr and points on the north coast and in central Germany. By October 14, traffic on the Rhine had been interdicted by a bomb that detonated a German demolition charge on a bridge at Cologne. Traffic in the Ruhr dropped sharply and all water movement of coal to south Germany ceased.

The effect of this progressive traffic tie-up was found, as might be expected, to have first affected commodities normally shipped in less-than-trainload lots—finished and semi-finished manufactured goods, components, perishable consumer goods and the less bulky raw materials. Cars loaded with these commodities had to be handled through the marshalling yards and after the September and October attacks this became increasingly difficult or impossible. Although output of many industries reached a peak in late summer and declined thereafter, total output of the economy was on the whole well-maintained through November. Beginning in December there was a sharp fall in production in nearly all industries; week by week the decline continued until the end of the war.

Although coal traffic (about 40 percent of all the traffic carried by the German railways) held up better than miscellaneous commercial traffic, the decline was both more easily traceable and more dramatic. The September raids reduced coal-car placements in the Essen Division of the Reichsbahn (the originator of most of the coal traffic of the Ruhr) to an average of 12,000 cars daily as compared with 21,400 at the beginning of the year. Most of this was for consumption within the Ruhr. By January, placements in the Ruhr were down to 9,000 cars a day and in February virtually complete interdiction of the Ruhr District was achieved. Such coal

as was loaded was subject to confiscation by the railroads to fuel their locomotives; even with this supply, coal stocks of the Reichsbahn itself were reduced from 18 days' supply in October 1944 to 4½ days' supply in February 1945. By March some divisions in southern Germany had less than a day's supply on hand, and locomotives were idle because of lack of coal.

The German economy was powered by coal; except in limited areas, the coal supply had been eliminated.

Military (Wehrmacht) traffic had top priority over all other traffic. During the period of attack this traffic came to account for an ever-increasing proportion of the declining movement. Through 1944 the air attack did not prevent the army from originating such movements although the time of arrival or even the arrival of units and equipment became increasingly uncertain. Couriers accompanied detachments and even shipments of tanks and other weapons; their task was to get off the train when it was delayed and report where it could be found. After the turn of the year even military movements became increasingly difficult. The Ardennes counter-offensive, the troops and equipment for which were marshalled over the railroads, was probably the last such effort of which the Reichsbahn would have been capable in the west.

Electric Power

The German power system, except for isolated raids, was never a target during the air war. An attack was extensively debated during the course of the war. It was not undertaken partly because it was believed that the German power grid was highly developed and that losses in one area could be compensated by switching power from another. This assumption, detailed investigation by the Survey had established, was incorrect.

The German electric power situation was in fact in a precarious condition from the beginning of the war and became more precarious as the war progressed; this fact is confirmed by statements of a large number of German officials, by confidential

memoranda of the National Load Dispatcher, and secret minutes of the Central Planning Committee. Fears that their extreme vulnerability would be discovered were fully discussed in these minutes.

The destruction of five large generating stations in Germany would have caused a capacity loss of 1.8 million kw. or 8 percent of the total capacity, both public and private. The destruction of 45 plants of 100,000 kw. or larger would have caused a loss of about 8,000,000 kw. or almost 40 percent, and the destruction of a total of 95 plants of 50,000 kw. or larger would have eliminated over one-half of the entire generating capacity of the country. The shortage was sufficiently critical so that any considerable loss of output would have directly affected essential war production, and the destruction of any substantial amount would have had serious results.

Generating and distributing facilities were relatively vulnerable and their recuperation was difficult and time-consuming. Had electric generating plants and substations been made primary targets as soon as they could have been brought within range of Allied attacks, the evidence indicates that their destruction would have had serious effects on Germany's war production.

The Civilians

A word should perhaps be added on the effect of the air war on the German civilian and on the civilian economy. Germany began the war after several years of full employment and after the civilian standard of living had reached its highest level in German history. In the early years of the war—the soft war period for Germany—civilian consumption remained high. Germans continued to try for both guns and butter. The German people entered the period of the air war well stocked with clothing and other consumer goods. Although most consumer goods became increasingly difficult to obtain, Survey studies show that fairly adequate supplies of clothing were available for those who had been bombed out until

the last stages of disorganization. Food, though strictly rationed, was in nutritionally adequate supply throughout the war. The Germans' diet had about the same calories as the British.

German civilian defense was examined by Survey representatives familiar with U.S. and British defenses. The German system had been devised as protection against relatively small and isolated attacks. The organization had to be substantially revised when the attacks grew to saturation proportions. In particular, arrangements were made by which a heavily bombed community might call on the fire-fighting and other defensive resources of surrounding communities and, as a final resort, on mobile reserves deployed by the central government through the more vulnerable areas. In the attacks on German cities incendiary bombs, ton for ton, were found to have been between four and five times as destructive as high explosive. German fire defenses lacked adequate static and other water reserves replenished by mains independent of the more vulnerable central water supply. However, in the more serious fire raids, any fire-fighting equipment was found to have been of little avail. Fire storms occurred, the widespread fires generating a violent hurricane-like draft, which fed other fires and made all attempts at control hopeless.

German shelters, so far as they were available, were excellent. In England the policy was to build a large number of shelters which protected those taking refuge from bombs falling in the area and from falling and flying debris but which were not secure against a direct hit. The Germans, by contrast, built concrete bunkers, some of enormous size, both above and below ground, designed to protect those taking shelter even against a direct hit. One such shelter in Hamburg, named the "Holy Ghost" for its location on Holy Ghost Plaza, sheltered as many as 60,000 people. There were not, however, enough such shelters; at the close of the war shelter accommodation was available for only about eight million people. The remainder sheltered in basements, and casualties in these places of refuge were heavy. After raids the Germans did not

attempt systematic recovery of all bodies or even of all trapped persons. Those that could not readily be removed were left.

Official German statistics place total casualties from air attack—including German civilians, foreigners, and members of the armed forces in cities that were being attacked—at 250,253 killed for the period from January 1, 1943, to January 31, 1945, and 305,455 wounded badly enough to require hospitalization, during the period from October 1, 1943, to January 31, 1945. A careful examination of these data, together with checks against records of individual cities that were attacked, indicates that they are too low. A revised estimate prepared by the Survey (which is also a minimum) places total casualties for the entire period of the war at 305,000 killed and 780,000 wounded. More reliable statistics are available on damage to housing. According to these, 485,000 residential buildings were totally destroyed by air attack and 415,000 were heavily damaged, making a total of 20 percent of all dwelling units in Germany. In some 50 cities that were primary targets of the air attack, the proportion of destroyed or heavily damaged dwelling units is about 40 percent. The result of all these attacks was to render homeless some 7,500,000 German civilians.

It is interesting to note some of the effects of air attack upon medical care and military casualties during the war. The aerial warfare against Germany forced the German military and civilian authorities to recognize that national health and medical problems were a joint responsibility. The destruction of hospital equipment, pharmaceutical production, and medical supplies, incident to area raids, forced a dispersal of medical supply installations and the removal of hospitals from city to suburban and country sites. This program came in late 1943 at a time when air raids on cities were causing increased casualties among civilians and resulted in shortages in ether, plasters, serums, textiles, and other medical supplies. At the same time the increased tempo of tactical air action was having an effect on military casualty rates, and is reflected in the fact that, according to German reports, war casualties from aerial weapons moved from third place in 1942 to first place in late 1943, 1944, and 1945, followed in order by artillery fire and

infantry weapons. The casualty effects of air action are shown by the fact that the proportion of wounded to killed shifted from a ratio of eight to one in 1940 and 1941 to a ratio of three to one in 1944 and 1945. Personnel wounded by air action suffered as a rule multiple wounds and shock, resulting in longer periods of hospitalization and convalescence, and in a decided reduction in the number of patients who could be returned to either full or limited military duty.

Conclusion

The foregoing pages tell of the results achieved by Allied air power, in each of its several roles in the war in Europe. It remains to look at the results as a whole and to seek such signposts as may be of guidance to the future.

Allied air power was decisive in the war in Western Europe. Hindsight inevitably suggests that it might have been employed differently or better in some respects. Nevertheless, it was decisive. In the air, its victory was complete. At sea, its contribution, combined with naval power, brought an end to the enemy's greatest naval threat—the U-boat; on land, it helped turn the tide overwhelmingly in favor of Allied ground forces. Its power and superiority made possible the success of the invasion. It brought the economy which sustained the enemy's armed forces to virtual collapse, although the full effects of this collapse had not reached the enemy's front lines when they were overrun by Allied forces. It brought home to the German people the full impact of modern war with all its horror and suffering. Its imprint on the German nation will be lasting.

Some Signposts

1. The German experience suggests that even a first class military power—rugged and resilient as Germany was—cannot live

long under full-scale and free exploitation of air weapons over the heart of its territory. By the beginning of 1945, before the invasion of the homeland itself, Germany was reaching a state of helplessness. Her armament production was falling irretrievably, orderliness in effort was disappearing, and total disruption and disintegration were well along. Her armies were still in the field. But with the impending collapse of the supporting economy, the indications are convincing that they would have had to cease fighting—any effecting fighting—within a few months. Germany was mortally wounded.

2. The significance of full domination of the air over the enemy—both over its armed forces and over its sustaining economy—must be emphasized. That domination of the air was essential. Without it, attacks on the basic economy of the enemy could not have been delivered in sufficient force and with sufficient freedom to bring effective and lasting results.

3. As the air offensive gained in tempo, the Germans were unable to prevent the decline and eventual collapse of their economy. Nevertheless, the recuperative and defensive powers of Germany were immense; the speed and ingenuity with which they rebuilt and maintained essential war industries in operation clearly surpassed Allied expectations. Germany resorted to almost every means an ingenious people could devise to avoid the attacks upon her economy and to minimize their effects. Camouflage, smoke screens, shadow plants, dispersal, underground factories, were all employed. In some measure all were helpful, but without control of the air, none was really effective. Dispersal brought a measure of immediate relief, but eventually served only to add to the many problems caused by the attacks on the transportation system. Underground installations prevented direct damage, but they, too, were often victims of disrupted transportation and other services. In any case, Germany never succeeded in placing any substantial portion of her war production underground—the effort was largely limited to certain types of aircraft, their components, and the V weapons. The practicability of going underground as the escape from full and free exploitation of the air is highly questionable, it

was so considered by the Germans themselves. Such passive defenses may be worthwhile and important, but it may be doubted if there is any escape from air domination by an enemy.

4. The mental reaction of the German people to air attack is significant. Under ruthless Nazi control they showed surprising resistance to the terror and hardships of repeated air attack, to the destruction of their homes and belongings, and to the conditions under which they were reduced to live. Their morale, their belief in ultimate victory or satisfactory compromise, and their confidence in their leaders declined, but they continued to work efficiently as long as the physical means of production remained. The power of a police state over its people cannot be underestimated.

5. The importance of careful selection of targets for air attack is emphasized by the German experience. The Germans were far more concerned over attacks on one or more of their basic industries and services—their oil, chemical, or steel industries or their power or transportation network—than they were over attacks on their armament industry or the city areas. The most serious attacks were those which destroyed the industry or service which most indispensably served other industries. The Germans found it clearly more important to devise measures for the protection of basic industries and services than for the protection of factories turning out finished products.

6. The German experience showed that, whatever the target system, no indispensable industry was permanently put out of commission by a single attack. Persistent re-attack was necessary.

7. In the field of strategic intelligence, there was an important need for further and more accurate information, especially before and during the early phases of the war. The information on the German economy available to the United States Air Forces at the outset of the war was inadequate. And there was no established machinery for coordination between military and other governmental and private organizations. Such machinery was developed during the war. The experience suggests the wisdom of establishing such arrangements on a continuing basis.

8. Among the most significant of the other factors which contributed to the success of the air effort was the extraordinary progress during the war of Allied research, development, and production. As a result of this progress, the air forces eventually brought to the attack superiority in both numbers and quality of crews, aircraft, and equipment. Constant and unending effort was required, however, to overcome the initial advantages of the enemy and later to keep pace with his research and technology. It was fortunate that the leaders of the German Air Force relied too heavily on their initial advantage. For this reason they failed to develop, in time, weapons, such as their jet-propelled planes, that might have substantially improved their position. There was hazard, on the other hand, in the fact that the Allies were behind the Germans in the development of jet-propelled aircraft. The German development of the V weapons, especially the V-2, is also noteworthy.

9. The achievements of Allied air power were attained only with difficulty and great cost in men, material and effort. Its success depended on the courage, fortitude, and gallant action of the officers and men of the air crews and commands. It depended also on a superiority in leadership, ability, and basic strength. These led to a timely and careful training of pilots and crews in volume; to the production of planes, weapons, and supplies in great numbers and of high quality; to the securing of adequate bases and supply routes; to speed and ingenuity in development; and to cooperation with strong and faithful Allies. The failure of any one of these might have seriously narrowed and even eliminated the margin.

Of the Future

The air war in Europe was marked by continuous development and evolution. This process did not stop on VE-day; great strides have been made since in machines, weapons, and techniques. No greater or more dangerous mistake could be made than to assume

that the same policies and practices that won the war in Europe will be sufficient to win the next one—if there be another. The results achieved in Europe will not give the answer to future problems; they should be treated rather as signposts pointing the direction in which such answers may be found.

The great lesson to be learned in the battered towns of England and the ruined cities of Germany is that the best way to win a war is to prevent it from occurring. That must be the ultimate end to which our best efforts are devoted. It has been suggested—and wisely so—that this objective is well served by insuring the strength and the security of the United States. The United States was founded and has since lived upon principles of tolerance, freedom, and good will at home and abroad. Strength based on these principles is no threat to world peace. Prevention of war will not come from neglect of strength or lack of foresight or alertness on our part. Those who contemplate evil and aggression find encouragement in such neglect. Hitler relied heavily upon it.

Suggestions for assuring the strength and security of the United States are by no means intended as a recommendation for a race in arms with other nations. Nor do they reflect a lack of confidence in the prospect of international relationships founded upon mutual respect and good will which will themselves be a guarantee against future wars. The development of an intelligent and coordinated approach to American security can and should take place within the framework of the security organization of the United States.

In maintaining our strength and our security, the signposts of the war in Europe indicate the directions in which greater assurances may be found. Among these are intelligent long-range planning by the armed forces in close and active cooperation with other government agencies, and with the continuous active participation of independent civilian experts in time of peace as well as in war; continuous and active scientific research and technical development on a national scale in time of peace as well as in war; a more adequate and integrated system for the collection and evaluation of intelligence information; that form of organization of the armed forces which clarifies their functional responsibilities and favors a

higher degree of coordination and integration in their development, their planning, their intelligence, and their operations; and, finally, in time of peace as well as in war, the highest possible quality and stature of the personnel who are to man the posts within any such organization, whatever its precise form may be—and in this, quality, not numbers, is the important criterion.

The air has become a highway which has brought within easy access every point on the earth's surface—a highway to be traveled in peace, and in war, over distances without limit at ever-increasing speed. The rapid developments in the European war foreshadow further exploration of its potentialities. Continued development is indicated in the machines and in the weapons which will travel the reaches of this highway. The outstanding significance of the air in modern warfare is recognized by all who participated in the war in Europe or who have had an opportunity to evaluate the results of aerial offensive. These are facts which must govern the place accorded air power in plans for coordination and organization of our resources and skills for national defense.

Speed, range, and striking power of the air weapons of the future, as indicated by the signposts of the war in Europe must—specifically—be reckoned with in any plans for increased security and strength. The combination of the atomic bomb with remote-control projectiles of ocean-spanning range stands as a possibility which is awesome and frightful to contemplate.

These are some of the many factors which will confront our national leaders who will have primary responsibility for correctly reading the signposts of the past. It is hoped that the studies of the German war, summarized here, and studies being conducted by the Survey in Japan, will help them in their task.

JAPANESE EXPANSION
1868 TO NOVEMBER 1941
AND
7 DECEMBER 1941 TO 9 JULY 1942
PACIFIC OCEAN

UNITED STATES
STRATEGIC BOMBING SURVEY

SUMMARY REPORT

(Pacific War)

WASHINGTON, D. C.

1 JULY 1946

FOREWORD

The United States Strategic Bombing Survey was established by the Secretary of War on 3 November 1944, pursuant to a directive from the late President Roosevelt. It was established for the purpose of conducting an impartial and expert study of the effects of our aerial attack on Germany, to be used in connection with air attacks on Japan and to establish a basis for evaluating air power as an instrument of military strategy, for planning the future development of the United States armed forces, and for determining future economic policies with respect to the national defense. A summary report and some 200 supporting reports containing the findings of the Survey in Germany have been published. On 15 August 1945, President Truman requested the Survey to conduct a similar study of the effects of all types of air attack in the war against Japan.

The officials of the Survey in Japan, who are all civilians, were:

Franklin D'Olier, *Chairman*
Paul H. Nitze
Henry C. Alexander, *Vice Chairmen*
Harry L. Bowman
J. Kenneth Galbraith
Rensis Likert
Frank A. McNamee, Jr.
Fred Searls, Jr.
Monroe E. Spaght
Dr. Louis R. Thompson
Theodore P. Wright, *Directors*
Walter Wilds, *Secretary*

The Survey's complement provided for 300 civilians, 350 officers, and 500 enlisted men. Sixty percent of the military segment of the organization for the Japanese study was drawn from

the Army, and 40 percent from the Navy. Both the Army and the Navy gave the Survey all possible assistance in the form of men, supplies, transport, and information. The Survey operated from headquarters in Tokyo, with subheadquarters in Nagoya, Osaka, Hiroshima, and Nagasaki, and with mobile teams operating in other parts of Japan, the islands of the Pacific, and the Asiatic mainland.

The Survey secured the principal surviving Japanese records and interrogated top Army and Navy officers, Government officials, industrialists, political leaders, and many hundreds of their subordinates throughout Japan. It was thus possible to reconstruct much of wartime Japanese military planning and execution, engagement by engagement and campaign by campaign, and to secure reasonably accurate data on Japan's economy and war production, plant by plant, and industry by industry. In addition, studies were made of Japan's over-all strategic plans and the background of her entry into the war, the internal discussions and negotiations leading to her acceptance of unconditional surrender, the course of health and morale among the civilian population, the effectiveness of the Japanese civilian defense organization and the effects of the atomic bomb. Separate reports will be issued covering each phase of the study.

In this Summary Report the civilian officials and directors of the Survey have not undertaken to write a history of the Pacific war, nor to apportion credit for victory among the various component Allied forces. They have undertaken, as civilians, to present an analysis of the factual material gathered by the Survey and their general appraisal thereof as to the future.

SUMMARY REPORT

The attack on Pearl Harbor was designed around surprise, the range of carrier task forces, and the power of aircraft to sink surface vessels. It was executed with the loss of 29 Japanese pilots. Two days later, the Japanese found the British battleship, *Prince of Wales,* and the battle cruiser, *Repulse,* without air cover off Malaya and sent them to the bottom with the loss of 4 Japanese Navy medium bombers. Allied air power in the Philippines, Malaya, and the Dutch East Indies was virtually eliminated, mostly on the ground, in a matter of days. Those enormous areas, once local Allied air power had been eliminated, were laid open to occupation in a matter of weeks, at a cost of less than 15,000 Japanese soldiers killed, and with the loss from all causes in the entire campaign of 381 Japanese planes.

As these achievements indicate, the Japanese started the war aware of the fact that major offensive action cannot be undertaken without local control of the air. They also appreciated the vulnerability to air attack of surface objectives, both on land and at sea. The Japanese failed, however, to appreciate the full scope and complexity of the requirements for continuing control of the air. The Japanese aircraft production program at the start of the war was inadequate, as the Japanese subsequently discovered, not only in relation to that of the United States, but even in relation to the capabilities of their own economy. Their planning and execution with respect to training, maintenance, logistics, technical development, intelligence and full coordination with their land and surface forces, were limited in relation to the requirements that subsequently developed. Japan's war plans did not contemplate, nor were its capabilities such that it could have contemplated, interference with the sustaining resources of United States air power.

December 7, 1941, found the United States and its Allies provocatively weak in the Pacific, particularly in land and carrier-based air power. The Allied air groups actually in the Pacific were not only few in number but, in large measure, technically inferior to those of the Japanese. The Japanese strength had been underestimated. Ninety P–40s and 35 B–17s in the Philippines could not be expected to check the Japanese push southward. Three of our seven aircraft carriers were in the Atlantic and one training in the Gulf of Mexico. Even at that time, however, we had begun to see, more clearly than the Japanese, the full scope of the basic requirements for air power. Our programs for training, production, maintenance, logistics, and intelligence were limited, not so much by a lack of concept as by the time required for their development and fulfillment.

How the original Japanese advance was stopped, how we achieved air superiority, at first locally, but subsequently more and more generally, and over areas deep within the one-time Japanese dominated areas, culminating finally in air supremacy over the Japanese home islands themselves, and how that air superiority was exploited, is the story of air power in the Pacific war and the subject matter of this Summary Report. The role of air power cannot be considered separately, however, from the roles of ground and naval forces nor from the broad plans and strategy under which the war was conducted.

Japan's Original Strategic Plan

Japan's governmental structure provided no effective civilian control of her Army and Navy. In the years between the 1931 invasion of Manchuria and the 1941 attack upon Pearl Harbor, the military cliques of Japan exerted a progressively tighter control over the foreign and domestic affairs of the nation. These cliques included groups within both the Army and Navy, but because of the repeated military successes of the Japanese Army in Manchuria and China and the prestige so acquired, and because of the more

ambitious and aggressive nature of the Japanese Army leaders, the political position of the Army was ascendant to that of the Navy. The final decision to enter the war and to advance into the Philippines, the Dutch East Indies, Malaya, Burma and to the southeast was, however, made with the full concurrence and active consent of all important Japanese Army and Navy leaders and of almost all her important civilian leaders.

This decision to which the Japanese were, in effect, committed by mid-October 1941 was based upon the following evaluation:

a. The threat of Russia on the Manchurian flank had been neutralized by the decisive victories of Germany in Europe which might eventually lead to the complete collapse of the Soviet Union.

b. Great Britain was in such an irretrievably defensive position that, even if she survived, her entire war-making potential would be spent in a desperate effort to protect her home islands.

c. The forces which the United States and her Allies could immediately deploy in the Pacific, particularly in the air, were insufficient to prevent the fully trained and mobilized forces of Japan from occupying within three or four months the entire area enclosed within a perimeter consisting of Burma, Sumatra, Java, northern New Guinea, the Bismarck Archipelago, the Gilbert and Marshall Islands, Wake, and from there north to the Kuriles.

d. China, with the Burma Road severed, would be isolated and forced to negotiate.

e. The United States, committed to aiding Great Britain, and weakened by the attack on Pearl Harbor, would be unable to mobilize sufficient strength to go on the offensive for 18 months to 2 years. During this time, the perimeter could be fortified and the required forward air fields and bases established. So strengthened, this perimeter would be backed by a mobile carrier striking force based on Truk.

f. While the stubborn defense of the captured perimeter was undermining American determination to support the war, the Japanese would speedily extract bauxite, oil, rubber and metals from Malaya, Burma, the Philippines and the Dutch East Indies,

and ship these materials to Japan for processing, to sustain and strengthen her industrial and military machine.

g. The weakness of the United States as a democracy would make it impossible for her to continue all-out offensive action in the face of the losses which would be imposed by fanatically resisting Japanese soldiers, sailors and airmen, and the elimination of its Allies. The United States in consequence would compromise and allow Japan to retain a substantial portion of her initial territorial gains.

Certain civilian and naval groups were familiar with the United States, its industrial and technological potential, and probable fighting determination when aroused. They expressed doubts about a strategy which promised no conclusion to the war other than negotiation, and which thus might drag out interminably with consequent risk of defeat. The Navy, however, was gravely concerned about its declining oil supply after the United States and the British economic embargo of July 1941. Such civilians as were reluctant were overruled and went along with the more dynamic opinion.

None of the responsible Japanese leaders believed that within any foreseeable period of time Japan could invade the United States and dictate peace in the White House. Admiral Yamamoto's supposed boast that Japan would do so was in fact never made. These leaders furthermore felt that Japan's limited shipping would be strained to the utmost in providing logistic support for the plan adopted and would be wholly inadequate for any more ambitious program, unless the initial operations went unexpectedly well.

Execution of the Japanese Plan

In accordance with the above plan, the Japanese Army was given primary responsibility for conquering Malaya, Sumatra and Burma and, because of the limited range of its planes, for furnishing initial air support in northern Luzon only above 16° north latitude. The Japanese Navy was assigned primary responsibility, in addition to

the attack on Pearl Harbor, for initially launching operations in the Philippines, Borneo, Celebes, Java, northern New Guinea, the Bismarck Archipelago and out to the Gilbert Islands and Wake. The Army was to assume control in the Philippines as soon as the landing forces were established ashore. On 7 December 1941 the Japanese Army and Navy air forces were accordingly disposed as follows:

Unit	*Aircraft Strength*	*Deployment*
ARMY		
Third Flying Division	550	Malayan Campaign
Fifth Flying Division	175	Philippines Campaign
First Flying Brigade	150	China
Second Flying Division	450	Manchuria (Reserve)
First Flying Division	50	Japan
Total Army	1,375	

Unit	*Aircraft Strength*	*Deployment*
NAVY		
Twenty-first and Twenty-third Air Flotillas	300	Philippines Campaign
Twenty-second Air Flotilla	150	Malayan Campaign
Twenty-fourth Air Flotilla	50	Marshalls
Carrier Force (6 CVs)	400	Pearl Harbor
Combined Fleet	75	Seaplanes attached to surface vessels
Miscellaneous	275	Japan
Total Navy	1,250	
Grand Total	2,625	

The Japanese were not depending solely upon the volume of their air strength in these initial engagements, although they believed they possessed sufficient superiority in numbers over Allied air forces in the Pacific. More than on numbers, the Japanese relied on surprise and speed of advance, and upon the training and experience of their airmen. In 1941 the average first-line Japanese pilot had about 500–800 flying hours, and about 50 percent of Japanese Army pilots and 10 percent of Japanese Navy pilots had had actual combat experience in China or in border fighting with the Soviet Union in 1939. The carrier air groups were especially trained in shallow-water torpedo drops for the Pearl Harbor attack, and the Japanese Army air units were trained for support of ground operations in Malaya and the Philippines.

Facing the Japanese, the United States and its Allies had the following land-based air strength in the Pacific:

Country	*Aircraft Strength*	*Deployment*
U.S. Army and Navy Air Forces	182	Philippines
	12	Wake
	12	Midway
	387	Hawaii
Royal Netherlands East Indies Air Forces.....	200	Netherlands East Indies
Royal Air Force	332	Malaya
Royal Australian Air Forces.....	165	Australia, Solomons, Netherlands East Indies, and Malaya
Total Allied.....	1,290	

The majority of these planes were of obsolete types.

These forces were quickly overwhelmed. Fifty percent of the planes were destroyed on the ground. Our three lightly supported aircraft carriers in the Pacific did not constitute a sufficient force to warrant their being risked in those operations.

Following the initial successes at Pearl Harbor, Malaya and in the Philippines, Wake and Guam were occupied in December, and Rabaul in January. The Japanese gained air superiority in Burma with the loss of 102 planes and, with troops specially trained for jungle fighting, occupied that area at a cost of 7,000 soldiers killed. At the end of 4 months of war, they had carried out the substance of their initial program and with greater ease than they had foreseen. Total merchant shipping losses were 51 ships. Much of the equipment which had originally been scheduled for movement into the southern islands was found to be unnecessary and was left behind in order to achieve greater speed. Certain of the Japanese leaders were concerned by the skillful and unexpectedly determined resistance of our ground forces in the Philippines. They attributed this in part to inefficient Japanese close-air support. But in some circles the skill and determination with which our isolated forces conducted the defense was correctly assessed as an ominous cloud on the horizon.

Japanese Overextension

The magnitude of these successes encouraged the more daring Japanese planners to consider expansion beyond the original perimeter. During their discussions, the Doolittle raid of 18 April 1942 struck Tokyo. Although the damage caused was inconsequential, the reach of the attack supported a growing feeling that the Japanese perimeter would gain in strength if it had greater defense in depth.

Accordingly a new plan was approved, providing for *(a)* an advance into the Solomons and Port Moresby, to be followed, if successful, by a further advance into New Caledonia, Samoa and the Fiji Islands, *(b)* the capture of Midway, and *(c)* the temporary occupation of the Aleutians. Accomplishment of such a program would cut off the line of communication between Australia and the United States, reduce the threat from Alaska, and deny the United States all major staging areas more advanced than Pearl Harbor.

By stretching and overextending her line of advance, Japan was committed to an expensive and exacting supply problem, she delayed the fortification of the perimeter originally decided upon, jeopardized her economic program for exploiting the resources of the area already captured, and laid herself open to early counter-attack in far advanced and, as yet, weak positions.

The United States Plan Before Pearl Harbor

Prior to Pearl Harbor it had been decided that, in the event of war, Germany would have to be eliminated first, and that our initial role in the Pacific would, in large measure, be defensive. But Japan's offensive capabilities were underestimated; it was thought possible to hold the Malaya barrier, successfully engage the Japanese fleet in the Central Pacific, and lay the foundations for an eventual advance against Japan itself. The United States plan had little basis in reality. With the forces then available no adequate plan of defense was possible. The loss of relatively antiquated battleships at Pearl Harbor did not substantially reduce the actual combat capabilities of our Navy at that time as opposed to the Japanese Navy with its superiority in aircraft carriers and battle line speed. To have implemented an adequate plan in December 1941 would have required better intelligence regarding Japanese intentions and capabilities, an earlier understanding of the predominant and indispensable role of air strength and full public support for the necessary appropriations, well before the actual outbreak of war.

As it developed, all that we could do prior to May 1942, a part from the resistance of our isolated forces in the Philippines and sporadic carrier and land-based air raids, was to build up our strength in Australia and the islands lying between Pearl Harbor and Australia, while bringing to fruition our training and production programs.

Turning the Tide

United States preparations were still inadequate when it became evident that the Japanese intended to advance south from the Bismarck Archipelago, and thus threaten our communications with Australia. It was decided nevertheless to attempt to hold Port Moresby and a line north of Espiritu Santo and the Fiji Islands. Exceptional intelligence gave us advance information that a group of transports, protected by the Japanese carrier Shoho and by a covering force including two other carriers, was on its way to occupy Port Moresby in May 1942. This information enabled us to concentrate at the appropriate point two of our four carriers then available in the Pacific (one had come to the Pacific from the Atlantic, but two were returning from the Doolittle raid on Tokyo), and to sink the Shoho by torpedo-plane and dive-bomber attack. In the ensuing air engagement with the covering force, we damaged one of the Japanese carriers in that force, but lost the *Lexington*. The Japanese force had two carriers left to our one, but their air groups had been badly depleted. The transports turned back from Port Moresby to return to Rabaul and, for the first time, the Japanese advance had been checked. The combat in this Battle of the Coral Sea was entirely carrier air action.

Similar intelligence provided advance information as to the Japanese move toward Midway in June. In this case, the transports were supported by an advance striking force, including the most powerful surface forces yet assembled in the war and four of Japan's remaining eight operational carriers. An additional Japanese carrier was in a supporting force farther to the north. Again only weaker forces were available to the United States; three carriers, the *Enterprise, Yorktown,* and *Hornet,* the only ones available for combat action in the Pacific at that time, were rushed to the attack. Our planes located the Japanese fleet and sank three of the enemy carriers, and so damaged the fourth that she subsequently fell an easy prey to a United States submarine. Deprived of its carriers the Japanese Fleet was forced to retire

despite its preponderance in heavy ship strength. Survey interrogations of surviving officers from the Japanese carriers indicate that they were sunk by carrier-based dive bombers. Two-thirds of the pilots on the Japanese carriers sunk were rescued by Japanese destroyers. Some of the Japanese carrier-based planes discovered our carriers and succeeded in damaging the *Yorktown* so seriously that she went dead in the water and was sunk by a Japanese submarine. Except for the finishing off of stragglers by submarines, the combat in this engagement was entirely air action.

Immediately after Midway, the Japanese had 4 carriers fit for action, shortly to be joined by a fifth; but of these only 1 was large. In addition, they had 6 carriers under repair or construction. The United States had 3 large carriers operational in the Pacific and 13 carriers, and 15 escort carriers, either being readied for operation, or under construction. The Japanese Navy, thereafter, was hobbled by its weakness in the air, and could engage our forces only at night or under cover of land-based air until that air strength was rebuilt. A balance of naval air power in the Pacific, and as a consequence a balance of naval power as a whole, was thus achieved at Midway.

The scene of intense conflict shifted back to the islands south of Rabaul, the seas surrounding them, and the air over both. The Japanese had determined to renew their efforts to capture Port Moresby, if necessary by the overland route from the northern shore of New Guinea, and were constructing air fields in the Solomons. The United States Joint Chiefs of Staff ordered a two-pronged attack; one directed toward northern New Guinea from Port Moresby, the other up the chain of the Solomon Islands beginning with Guadalcanal; both with the final objective of capturing Rabaul. General MacArthur and Admiral Ghormley considered the forces available to them inadequate, but, in view of the importance of maintaining the line of communication with Australia, they were ordered to go ahead with what they had. A test of the Japanese perimeter thereby developed earlier than the Japanese had expected.

While the Southwest Pacific command was building air fields in northern Australia, Port Moresby and Milne Bay, the Japanese

landed, on 21 July 1942, at Buna on the north coast of New Guinea opposite Port Moresby and infiltrated over the Owen Stanley Range. Their lines of communications were cut by air attacks, their advance columns strafed and their attack held and pushed back by ground forces, in part supplied by air. The Japanese testify that they were unable to reinforce this attack to the extent they had planned because of developments at Guadalcanal.

On 7 August 1942, a surprise landing was made on Guadalcanal. Three United States carriers gave initial air support and the Marines who landed quickly captured the air field (later named Henderson Field) which was under construction by the Japanese. Interrogation of the senior Japanese commanders involved in the Solomons campaign indicates that they originally misjudged the strength of our attack and sent in only one reinforcement battalion of 500 men on fast destroyers from Truk. After this battalion was virtually destroyed, they sent in 5 more which again were not quite sufficient. Finally, they attempted to send in whole divisions. Thirty thousand troops were landed but, by that time, it was too late. Local control of the air provided by planes based on Henderson Field made it possible, but barely possible, to defend our unloading supply ships in the daytime, and made it impossible for the Japanese to land, except at night and then under hazardous and unsatisfactory conditions. The efforts of the Japanese to run in reinforcements at night, and at times to shell our shore installations, resulted in a series of night naval surface engagements which caused heavy losses to both sides. Our air strength was initially limited, was maintained by desperate and irregular reinforcement, and at one time was reduced by enemy naval bombardment to only 5 operational airplanes. The Japanese constructed a chain of air fields between Guadalcanal and Rabaul, and attempted to raid our ships and installations. In the air actions, however, they suffered increasingly heavy losses, not merely in numbers, but also in proportion to United States losses. The Japanese paint a vivid picture of the intolerable position in which inability to achieve air control placed them. General Miyazaki testified that only 20

percent of the supplies dispatched from Rabaul to Guadalcanal ever reached there. As a result the 30,000 troops they eventually landed on Guadalcanal lacked heavy equipment, adequate ammunition and even enough food, and were subjected to continuous harassment from the air. Approximately 10,000 were killed, 10,000 starved to death, and the remaining 10,000 were evacuated in February 1943, in a greatly weakened condition.

By the end of 1942, the most serious of the Japanese attempts to drive us off Guadalcanal had been thrown back and Allied operations to capture the Buna area were drawing to a close. We were securely established in these critical areas and had gradually built up local superiority in all arms, air, ground and sea. Our losses had been heavy. The Japanese, however, had suffered a crucial strategic defeat. Their advance had been stopped, their strategic plan fatally upset, many of their best pilots lost, and Allied forces firmly installed in positions in the Solomons and New Guinea, which threatened the anchor of their perimeter at Rabaul. In opposing this threat, the Japanese committed in piecemeal fashion and lost all of their fully trained Navy air units, including those rescued at Midway, and a portion of their best Army air units. The Japanese never fully recovered from this disaster, the effects of which influenced all subsequent campaigns. For the first time, the few Japanese who had all the facts at their disposal appreciated the seriousness of the situation. Greatly expanded programs for the training of pilots and the production of aircraft, radar and communications equipment, antiaircraft guns and ammunition, cargo vessels and tankers, were drawn up, but time was required to implement them.

The initiative had passed to the United States.

Factors Determining the Nature of the Succeeding Campaign

After the engagements of 1942, certain basic lessons of combat in the Pacific theater had been learned. It appeared that the widely

spread Japanese positions could be bypassed or captured, provided that air superiority in the necessary areas was achieved, and provided the required naval support, adequate assault craft, properly trained troops, and full logistics were available. Major preparations were required before decisive advances could be undertaken. In the meantime, however, unremitting pressure could be kept on the Japanese.

Due to the geography of the Empire, the Japanese ground forces depended for their effectiveness upon overseas support in all areas except the main home islands, and even there, overseas imports of raw materials were required. In China, Korea, and Manchuria, an overwater lit to the mainland was involved, and shipping was employed in the supply of troops in Malaya, Burma, and continental regions of the southwest. The islands of the eastern perimeter were completely dependent on supply by sea. Deployed as the Japanese ground forces were on detached land masses, dependent on inadequate shipping, their defeat was necessary only at points of United States choosing. The bulk of them could be bypassed.

The Japanese Navy, which included two 64,000-ton battleships of great fire-power and speed, had lost both operational freedom and striking power due to its limited carrier-based air strength. By late 1943, the United States had available sufficient carriers for clear-cut superiority in the air, and had added to the fleet sufficient modern heavy ships to offer reasonable protection against the Japanese surface strength were it to be committed under bad weather or other conditions limiting the degree to which our superiority in the air could be brought to bear. The ability to destroy the Japanese surface forces, if they were committed, was essential. Furthermore, their destruction would increase the freedom and ease of our further advances.

The limitations imposed by geography and the range of Japanese land-based planes made it impossible for the Japanese to achieve sufficient mobility of their land-based air forces to concentrate their full air strength against us at any crucial point, prior to the invasion of the Philippines and Okinawa. Most of the island atolls were too

small to support the necessary air fields, and in New Guinea, the Solomons and the Marianas, logistic, air field construction and ferrying problems made such concentration impossible. Even within the limits so imposed, poor Japanese staff work and tactics resulted in piecemeal employment of their available air strength. Over and above these weaknesses, Japanese aircraft production, pilot training and maintenance were so far behind our own that it was evident that general air superiority over the Japanese could be achieved. This objective received first priority.

The Japanese shipping target was immediately available. In the first year of the war, submarines, capable of long-range offensive action inside the Japanese perimeter, sank more than 10 percent and air planes 4 percent of the merchant ship tonnage which Japan possessed at the start of the war. The strangulation of Japanese overwater movement, thus begun, could be continued both by the submarine and by attack from the air.

Japanese industry and her home population would not be within effective striking distance of United States long-range bombers until bases within 1,500 nautical miles of Japan could be secured.

An advance to strategic positions across the Pacific would give us bases from which to complete the interdiction of Japan's overwater shipping, to mount large scale air attacks against the Japanese home islands, and to prepare for an invasion of the home islands themselves.

The Advance Across the Pacific

Such was the situation when the United States began its widespread offensive. While major preparations were still in progress, and the heavy attrition of the Solomons and eastern New Guinea campaign was chewing up Japan's best air groups and depleting her shipping and supplies, the first long-range moves in the advance across the Pacific were undertaken. These began unostentatiously with the assault against Attu, on the northern flank

of the Japanese defense perimeter in May 1943. On the southern flank, the offensive continued with an advance to Munda in June, to Salamaua, Lae, and Finschafen on New Guinea in September, and Bougainville in November 1943. In the Central Pacific it began with the assault on the Gilbert Islands in November 1943.

Thereafter, the amphibious advance toward Japan continued over two routes. One was up the north coast of New Guinea to the Philippines, the other across the Central Pacific through the Marshalls to the Marianas and Palaus and then subsequently on to Iwo Jima and Okinawa. Basically, the advance was for the purpose of projecting United States power to points which cut Japan's supply lines to the south and were within striking range of the Japanese home islands. Objectives were seized for one or more of four purposes: To provide forward air fields so that shore-based aircraft might maintain and project forward United States control of the air; to furnish advance bases for the fleet; to secure land areas for the staging of troops in succeeding advances; and, in the case of the Marianas, to provide bases for long-range air attacks on the Japanese home islands.

In the New Guinea area it continued to be possible to choose objectives for our advance where the enemy was weak, to seal off these objectives from enemy reinforcement and cover advances to them with land-based air, and, in certain instances, to supply the operation entirely by air. Marilinan, Nadzab and other inland bases on New Guinea, which eventually had complements as large as 25,000 men, were occupied, supplied and later moved forward entirely by air. The range of these advances was limited to the combat radius of fighter aircraft.

For long-range amphibious advances against strongly defended positions a typical pattern developed. Japanese bases flanking the United States objective were smothered by a concentration of air power. Such bases as were within reach were hammered by shore-based air. Carrier-based air and available shore-based air softened the area to be occupied, and as the amphibious force moved up, fast carriers advancing beyond the objective struck swift blows at all

positions which could threaten the objective area. With close air support from both escort and fast carriers and a concentration of gunfire from combatant ships of the support force, an amphibious assault over the beaches was made. The objective was secured under air support and cover from the carriers, which were not withdrawn until air fields ashore could be prepared and activated.

The amphibious steps along the two principal lines of advance toward Japan were well timed and mutually supporting, even though concentration on one line might have been more rapid. The losses inflicted at Rabaul, primarily by land-based planes from the Solomons and New Guinea, forced the Japanese to the decision not to support their garrisons in the Gilberts, were they to be attacked. The Central Pacific advance into the Gilbert and Marshall Islands in late 1943 and early 1944, and the threat of a fast carrier task force strike against Truk, which eventuated in February 1944, cleared the Japanese Fleet from the New Guinea flank and assisted the move into the Admiralties in March 1944 and the long step up the coast of New Guinea to Hollandia in April 1944, which was followed by a further advance to Wakde and Biak in May 1944. When the Japanese attempted reinforcement of northern New Guinea, the Central Pacific advance into the Marianas in June 1944, forced the abandonment of the operation. The Japanese committed their carriers in the defense of the Marianas, and lost in the Battle of the Philippines Sea practically all their carrier-based air groups sufficiently trained for combat, as well as three carriers sunk. Noemfoor was taken while the Japanese were preoccupied in the Marianas. Landings on Morotai were timed with those in the Palaus.

While the landings in the Palaus were in progress, the fast carrier task force struck Japanese aircraft, air fields and shipping in the Philippines. Preliminary to the Leyte operation, the fast carrier task force with a concentration of more than 1,000 planes attacked Okinawa, Formosa and the Philippines, exacting a large toll of Japanese air power. B–29 strikes from China against air installations on Formosa supported this operation. The landing at Leyte Gulf in the Philippines was correctly assessed by the

Japanese as their last opportunity, short of a defense of the Japanese home islands, to throw in all their available forces to check the United States advance in a decisive engagement.

Three days after the landing at Leyte they committed their entire fleet in a three-pronged attack. The plan contemplated that a carrier force advancing from the north would draw off our main strength, while heavy surface forces approaching through Surigao and San Bernardino Straits and covered by Japanese Army and Navy planes from air fields in the Philippines would destroy our transports and supporting strength off the landing beach. The Japanese strategy succeeded in drawing off our main strength to the north. The southern Japanese force was destroyed in a night surface engagement in Surigao Straits. Four carriers in the northern force were sunk off Luzon. Although one of its super-battleships had been sunk by torpedo plane attack, the central force penetrated close to our transports still possessed of overwhelming surface strength. The Japanese commander of the central force testified to the Survey that lack of expected land-based air support and air reconnaissance, fear of further losses from air attack, and worry as to his fuel reserves induced him to withdraw. As a result of this decision to retire, the Japanese failed to secure the objective for which catastrophic losses had been risked and suffered by the other two Japanese forces.

In the ensuing actions in the Philippines, the Japanese lost all the troops and supplies deployed there, plus three and one-half divisions sent in from China and Manchuria. In the Philippines campaign as a whole they committed and lost 9,000 planes. On 1 March 1945, the Japanese decided to send no further supplies to their ground forces outside of the home islands. Except for delaying actions they had been forced to concentrate solely on defense against invasion.

While the liberation of the Philippines was being completed, the Central Pacific forces made the difficult moves into Iwo Jima and Okinawa.

China–Burma–India

The Allied strategic plan contemplated that the actual defeat of Japan would be accomplished by operations in the Pacific. In the meantime, however, it was essential to defend India and to assist China. We could not afford to make substantial forces available. Our contribution in the China–Burma–India theater was almost entirely air and logistic support. The geography of the theater was such that overland transportation was virtually impossible beyond the Indian bases. As a consequence, the air in the China–Burma–India theater was called upon, not only to give protection against and to fight down enemy air and disrupt Japanese shipping and rail transportation, but also to transport the men and supplies for all forces and provide much of the fire power even in ground operations.

Full superiority over Japanese air forces was gradually attained. British ground forces at Imphal which had been surrounded by an attacking Japanese force were supplied by Allied air. The Japanese force was in turn isolated by air attack and destroyed. The troops that liberated Burma were moved, supplied, and supported by air. Japanese logistics in Burma and China were disrupted. China was kept in the war.

Over 1,180,000 tons of supplies and equipment and 1,380,000 troops were transported by air. The air movement over the "hump" between India and China attained a peak rate of 71,000 tons in 1 month.

In the fall of 1943 it was decided to attack Japanese industrial targets in Manchuria and Kyushu with B–29s flying from advanced bases in China. When this decision was reached, Guam, Saipan and Tinian had not yet been captured, and no other bases were available sufficiently close for direct strikes at the Japanese "Inner Zone" industries. The principal bottleneck in air operation in China was the transportation from India by air of the necessary supplies, most of which were allocated to supplying Chinese ground forces. As a result, the B–29s had sufficient supplies for only a small number of strikes per month. Data secured by the Survey in Japan established

that these strikes caused more severe damage to the Manchurian steel plants selected as targets than assessment of aerial photography had revealed. With the benefit of hindsight, however, it appears that the overall results achieved did not warrant the diversion of effort entailed and that the aviation gasoline and supplies used by the B–29s might have been more profitably allocated to an expansion of the tactical and antishipping operations of the Fourteenth Air Force in China. The necessary training and combat experience with B–29s provided by this operation might have been secured through attacks on "Outer Zone" targets, from bases more easily supplied. In November 1944, long-range bomber attacks from Guam, Saipan and Tinian were initiated. The B–29s based in China were transferred to these bases in April 1945.

By March 1945, prior to heavy direct air attack on the Japanese home islands, the Japanese air forces had been reduced to Kamikaze forces, her fleet had been sunk or immobilized, her merchant marine decimated, large portions of her ground forces isolated, and the strangulation of her economy well begun. What happened to each of these segments of Japan's vanishing war potential is analyzed in the following sections.

Elimination of Japanese Conventional Air Power

Japanese production of aircraft of all types rose from an average of 642 planes per month during the first 9 months of the war to a peak of 2,572 planes per month in September 1944. The rise was particularly great during 1943, after the Japanese had learned the lessons of the 1942 campaigns. Aggregate production during the war was 65,300 planes.

Japanese army and navy plane losses from all causes, both combat and noncombat, rose from an average rate of some 500 planes per month in the early months of the war to over 2,000 per month in the latter months of 1944. Aggregate losses during the course of the war were of the order of magnitude of 50,000 planes,

of which something less than 40 percent were combat losses, and something over 60 percent were training, ferrying, and other noncombat losses.

The Japanese were thus able to increase the numerical strength of their air forces in planes, in almost every month of the war. Numerical strength increased from 2,625 tactical planes at the outbreak of the war to 5,000 tactical planes, plus 5,400 Kamikaze planes, at the time of surrender.

Aggregate flying personnel increased from approximately 12,000 at the outbreak of the war to over 35,000 at the time of surrender.

United States aircraft production and pilot training exceeded the Japanese totals by wide margins, but only a portion of this strength could be deployed to the Pacific. United Sates first line strength in the Pacific west of Pearl Harbor increased from some 200 planes in 1941 to 11,000 planes in August 1945. It was not until late 1943 that we attained numerical superiority over the Japanese air forces in the field. Even in 1942, however, the relatively few United States air units in the Pacific were able to inflict greater losses than they sustained on the numerically superior Japanese. Aggregate United States plane losses during the course of the Pacific war, not including training losses in the United States, were approximately 27,000 planes. Of these losses 8,700 were on combat missions; the remainder were training, ferrying and other noncombat losses. Of the combat losses over 60 percent were to antiaircraft fire.

As previously stated, Japanese pilots at the outbreak of the war were well trained. The average Army pilot had some 500 hours before entering combat and Navy pilots 650 hours. These experienced pilots were largely expended during the bitter campaigns of the opening year and a half of the war. The Japanese paid far less attention than we did to the protection, husbanding and replacement of their trained pilots, and were seriously hampered in their training program by a growing shortage of aviation gasoline. Average flying experience fell off throughout the war, and was just over 100 hours, as contrasted to 600 hours for United States pilots,

at the time of surrender. Inadequately trained pilots were no match for the skilled pilots developed by the United States.

At the time of the initial Japanese attack, Japanese fighter planes, although less sturdily built, more vulnerable and weaker in fire power than the United States fighters, had certain flight characteristics superior to those of United States fighters then available in the Pacific. The Japanese improved the quality of their planes during the war, greatly increased the power of their aircraft engines, ultimately exceeded United States fighters in fire power and had first-class aircraft in the design and experimental stage at the end of the war. They lacked, however, the widespread technical and industrial skill to match the United States in quantity production of reliable planes with increased range, performance and durability. After the initial campaigns, the United States always enjoyed superiority in the over-all performance of its planes.

By American standards, the Japanese never fully appreciated the importance of adequate maintenance, logistic support, communications and control, and air fields and bases adequately prepared to handle large numbers of planes. As a result, they were unable to concentrate any large percentage of their air strength at any one time or place. Neither did they appear to have the ability to control large formations in the air with any degree of efficiency.

Local air control and its tactical exploitation the Japanese understood and achieved in their early offensives.

But along with all other military powers prior to the war, the Japanese had failed fully to appreciate the strategic revolution brought about by the increased capabilities of air power. The ability to achieve general and continuing control of the air was not envisaged as a requirement in their basic war strategy, as was the planned destruction of the United States Fleet. Had this basic requirement been well understood it is difficult to conceive that they would have undertaken a war of limited objectives in the first place. Once started on a strategic plan which did not provide the means to assure continuing air control, there was no way in which

they could revise their strategy to reverse the growing predominance in the air of a basically stronger opponent who came to understand this requirement and whose war was being fought accordingly.

Conversion of Japanese Air Forces to Kamikaze Forces

By the summer of 1944, it had become evident to the Japanese air commanders that there was no way in which they could equal the United States air arms at any point. Their losses were catastropic, while the results which they were achieving were negligible. The one and only asset which they still possessed was the willingness of their pilots to meet certain death. Under these circumstances, they developed the Kamikaze technique. A pilot who was prepared to fly his plane directly into a ship would require but little skill to hit his target, provided he got through the intervening screen of enemy fighters and antiaircraft fire. If sufficient Japanese planes attacked simultaneously, it would be impossible to prevent a certain proportion from getting through. Even though losses would be 100 percent of the planes and pilots thus committed, results, instead of being negligible, might be sufficient to cause damage beyond that which we would be willing to endure.

From October, 1944, to the end of the Okinawa campaign, the Japanese flew 2,550 Kamikaze missions, of which 475, or 18.6 percent were effective in securing hits or damaging near misses. Warships of all types were damaged, including 12 aircraft carriers, 15 battleships, and 16 light and escort carriers. However, no ship larger than an escort carrier was sunk. Approximately 45 vessels were sunk, the bulk of which were destroyers. The Japanese were misled by their own inflated claims of heavy ships sunk, and ignored the advice of their technicians that a heavier explosive head was required to sink large ships. To the United States the losses actually sustained were serious, and caused great concern. Two

thousand B–29 sorties were diverted from direct attacks on Japanese cities and industries to striking Kamikaze air fields in Kyushu. Had the Japanese been able to sustain an attack of greater power and concentration they might have been able to cause us to withdraw or to revise our strategic plans.

At the time of surrender, the Japanese had more than 9,000 planes in the home islands available for Kamikaze attack, and more than 5,000 had already been specially fitted for suicide attack to resist our planned invasion.

Destruction of the Japanese Fleet

As stated earlier in this report Japan started the war with 10 carriers. Six were sunk during the engagements of 1942. The Japanese during the course of the war constructed or converted from other types of ships a total of 17 additional carriers including 5 escort carriers; of the conversions one was made on a *Yamato*-class battleship hull and two, carriers only in part, were the result of removing the after turrets of battleships and installing small hangars and launching decks. Due to the loss of their trained carrier air groups in 1942–43 and the time required to train new ones, the Japanese did not commit their carriers again until 1944. In the engagements of that year the Japanese lost 7 carriers without themselves securing appreciable results. Seven more were lost in home waters to submarine or air attack. All Japanese carriers sunk were lost either to our carrier-based aircraft or to submarines with the exception of one which was finished off by surface vessels after it had been mortally damaged by carrier airplanes.

The Japanese had two *Yamato*-class battleships, each of 64,000 tons, armed with 18-inch guns and minutely compartmented, which were more powerful than any United States battleship. One was sunk in the Sibuyan Sea, the other south of Kyushu, both by carrier torpedo-planes.

Japan began the war with 381 warships aggregating approximately 1,271,000 tons. An additional 816 combat ships

totaling 1,048,000 tons were constructed during the war. Five hundred and forty-nine ships of all types and sizes, totaling 1,744,000 tons were sunk. Approximately 1,300,000 tons of Japanese warships in the carrier, battleship, cruiser and destroyer categories were included in the aggregate tonnage sunk. Of this total roughly 625,000 tons were sunk by Navy and Marine aircraft, 375,000 tons by submarines, 183,000 tons by surface vessels, 55,000 tons by Army aircraft, and 65,000 tons by various agents. Only 196,000 tons in these categories remained afloat at the end of the war. The tonnage sunk by surface ships was principally in night actions. A shortage of Japanese destroyers after 1943 and inadequate Japanese air antisubmarine measures contributed to the successes of United States submarines against the Japanese fleet.

After the liberation of the Philippines and the capture of Okinawa, oil imports into Japan were completely cut off; fuel oil stocks had been exhausted, and the few remaining Japanese warships, being without fuel, were decommissioned or were covered with camouflage and used only as antiaircraft platforms. Except for its shore-based Kamikaze air force and surface and undersea craft adapted for anti-invasion suicide attack, the Japanese Navy had ceased to exist.

Destruction of the Japanese Merchant Fleet

Japan's merchant shipping fleet, was not only a key link in the logistical support of her armed forces in the field, but also a vital link in her economic structure. It was the sole element of this basic structure which was vulnerable to direct attack throughout a major portion of the war.

Japan entered the war with some 6,000,000 tons of merchant shipping of over 500 tons gross weight. During the war an additional 4,100,000 tons were constructed, captured or requisitioned. Sufficient information was secured by the Survey in

Japan concerning this 10,100,000 tons to tabulate ship by ship, (*a*) the name and tonnage, (*b*) the date, location, and agent of sinking or damage, and (*c*) the present condition and location of such ships as survived. The sources from which evidence was obtained were in some respects conflicting. Where possible these conflicts have been resolved. The Joint Army and Navy Assessment Committee has tentatively arrived at similar results and is continuing its efforts further to refine the evidence. The Survey believes that the figures included in the following breakdown will not differ significantly from the final evaluation of the Joint Army and Navy Assessment Committee.

Eight million nine hundred thousand tons of this shipping were sunk or so seriously damaged as to be out of action at the end of the war. Fifty-four and seven-tenths percent of this total was attributable to submarines, 16.3 percent to carrier-based planes, 10.2 percent to Army land-based planes and 4.3 percent to Navy and Marine land-based planes, 9.3 percent to mines (largely dropped by B–29s), less than 1 percent to surface gunfire, and the balance of 4 percent to marine accidents.

Due to their ability to penetrate deeply into enemy-controlled waters, submarines accounted for approximately 60 percent of sinkings up until the final months of the war. During 1944, carrier task forces made deep sweeps which accounted for large numbers of ships. After April, 1945, when Japanese shipping was restricted to the Korean and Manchurian runs and to shallow inland waters, mines dropped by B–29s in Japanese harbors and inland waterways accounted for 50 percent of all ships sunk or damaged. In isolating areas of combat from ship-borne reinforcements land-based aircraft also sank large numbers of barges and vessels smaller than 500 tons gross weight, not included in the tabulation prepared by the Survey.

In the Survey's opinion those air units which had anti-shipping attacks as their prime mission and employed the required specialized techniques, equipment and training achieved against ships the best results for the effort expended.

The Japanese originally allocated two-thirds of their shipping fleet to the logistic support of their military forces in the field. They

expected that after their original advance had been completed they would be able to return increasing numbers of ships to the movement of raw materials for their basic economy. After the beginning of the Guadalcanal campaign, however, they were kept under such constant and unexpected military pressure that the contemplated returns after that date were never possible.

Up to the end of 1942, ship sinkings exceeded new acquisitions by a small margin. Thereafter, the aggregate tonnage sunk increased far more rapidily than could be matched by the expansion of the Japanese shipbuilding program. The size of the usable fleet thus declined continuously and at the end of the war amounted to little more than 10 percent of its original tonnage. The Japanese belatedly attempted to build up a convoy system, to re-route freight movements to rail lines, and to abandon more distant sources of supply, but these measures acted only as palliatives and not as cures. Furthermore, convoying and re-routing decreased the freight moved per ship by a factor amounting to 43 percent in the closing months of the war. In 1944 tanker losses became particularly heavy and were thereafter the first concern of the Japanese shipping authorities.

The basic economic consequences of ship sinking will be discussed in a later section. From the standpoint of the Japanese armed forces in the field it will be noted that 17 percent of army supplies shipped from Japan were sunk in 1943, 30 percent in 1944, and 50 percent in 1945. A shortage of fleet tankers was a continuing limitation on the mobility of the Japanese fleet and contributed to its defeat in the two crucial battles of the Philippine Sea. Inadequate logistic support, due in large part to lack of shipping, was one of the principal handicaps of the Japanese air forces.

Attacks by submarines, long-range search and attack planes, mines, and carrier and land-based planes were mutually supporting and complicated the Japanese defenses. Long-range air search found targets for the submarines; convoying which offered some protection against submarines increased the vulnerability to air

attack; ships driven into congested harbors in fear of submarines were easy prey for carrier strikes; and mines helped to drive ships out of shallow water into waters where submarines could operate. Had we constructed more submarines, earlier concentrated on tankers and more fully coordinated long-range air search and attack missions with submarine operations, the ship sinking program might have been even more effective.

Destruction or Isolation of Japanese Ground Forces

The Japanese built up their army ground forces from a strength of approximately 1,700,000 at the outbreak of war, to a peak strength of approximately 5,000,000. Japanese army medical records indicate that the aggregate number deployed in the Solomons, New Guinea, Marshalls, Gilberts, Carolines, Marianas, Philippines, Okinawa, Iwo Jima, and the Aleutians was approximately 668,000, of whom 316,000 were killed in action; some 220,000 were deployed in Burma, of whom 40,000 were killed; and 1,100,000 were deployed in China, of whom 103,000 were killed. Most of the remainder were in Manchuria, Korea, or the home islands, and did not actively participate in the decisive campaigns of the war.

The strategy of our advance and the limitations imposed on Japanese overwater transportation became such that the Japanese could concentrate only a small portion of their available Army ground forces strength at any of the critical island positions which we determined to capture. Japanese soldiers were unique in their willingness to face death and endure hardships. At every point where our Army or Marine forces engaged the Japanese on the ground after 1942, we enjoyed full air superiority. In every instance, except Ormoc in the Leyte campaign, we had eliminated Japanese ability to reinforce the critical area with either men or supplies. At Ormoc the Japanese were able to land 30,000 troops, but these reinforcements arrived piecemeal over too long a period

of time to be effective and many of the transports were sunk prior to unloading heavy equipment. In every instance where the Japanese had prepared defenses in a landing area these had been softened up by aerial bombardment and usually by naval shelling as well. It often proved impossible, however, to destroy more than a small percentage of the defending Japanese soldiers in preliminary softening up operations of even the greatest intensity. The Japanese were dug in, in tunnels, trenches and caves which were hard to find and often impossible to destroy, either by bombing or by naval shelling. Most of their fixed artillery positions were eliminated, but even some of these survived. The weight of fire on the immediate invasion beaches was generally such that the Japanese retired a short distance inland, but once we advanced beyond the beaches, it became necessary to destroy the remaining Japanese in costly close-range fighting. It was demonstrated, however, that Japanese resistance was effectively weakened and our casualties lighter when the appropriate weapons were employed with sufficient weight and accuracy in both preliminary softening up operations and subsequent close support.

A Japanese estimate indicates that in the southern regions, approximately 25 percent of their combat deaths resulted from aerial bombardment, 58 percent from small arms fire, 15 percent from artillery, and the remaining 2 percent from other causes.

In those places where it was essential to eliminate Japanese ground resistance in close-range fighting, great precision had to be developed in air-support operations in order to be certain not to hit our own troops, and to assure hits on the small targets which the critical Japanese positions presented. This required highly specialized training and the closest coordination between the ground and air forces through an intricate system of ground and air observers and unified control by ground-ship-air radio communication. In the Pacific war this system was continuously improved by the Navy and Marines in connection with succeeding amphibious operations against strongly defended positions and reached a high degree of effectiveness. In the Philippines campaign, the Army air forces employed comparable techniques,

and General Yamashita has testified to his feeling of complete helplessness when confronted with this type of opposition.

In the Southwest Pacific, it often proved possible to effect landings at lightly held positions, and thus bypass large bodies of enemy ground forces. In the Central Pacific, many of the islands the Japanese expected us to attack were bypassed, and the garrisons left to wither and die. Survey examination of the bypassed islands in the Pacific and interrogation of the Japanese survivors confirmed their intolerable situation. Their planes and ground installations were destroyed by air attack. Cut off from any supplies or reinforcements, except occasionally by submarine, their food ran out. On certain of the islands, Japanese actually ate Japanese. It appears, however, that our air attacks on these bypassed positions were often continued longer and in greater weight than was reasonably required or profitable.

The Japanese Economy Prior to Sustained Direct Air Attack

The orientation of the Japanese economy toward war began in 1928, and continued with increasing emphasis during the Manchurian and Chinese campaigns. By 1940, total production had arisen by more than 75 percent; heavy industrial production by almost 500 percent; and 17 percent of Japan's total output was being devoted to direct war purposes and expansion of her munition industries, as against 2.6 percent at that time in the United States. Construction of industrial facilities in these years assumed—for the Japanese conditions—gigantic proportions. Her aircraft, aluminum, machine tool, automotive, and tank industries were erected from almost nothing during this period.

This industrial expansion was based and depended on the availability of raw materials. Great efforts were devoted to the increase of raw material output in the home islands. In some respects, major results were achieved. Coal production in Japan

rose from 28,000,000 tons in 1931 to 55,600,000 tons in 1941. Domestic iron mining made considerable progress. Nevertheless, no country could have been farther from self-sufficiency, with respect to raw materials, than Japan. The development of basic material sources on the continent of Asia constituted almost the central issue of Japan's economic policy during this period.

Although progress in Manchuria and China helped significantly to alleviate Japan's raw material shortages in coking coal, iron ore, salt and foods, insufficiency of raw materials continued to be the most important limiting factor on Japanese industrial output. Negligible quantities of oil and no bauxite sources existed within Japan's "Inner Zone." Output of aluminum ingots had risen from 19 tons in 1933 to 71,740 in 1941, 90 percent of which was produced from bauxite imported from the Dutch East Indies. Plans to develop a synthetic oil industry failed to yield significant results and Japan was almost wholly dependent on oil imports from the United States or the Dutch East Indies. A similar dependence on imports existed for rubber, ferro-alloys such as manganese, chrome, nickel, cobalt and tungsten, and for nonferrous metals such as tin, lead, and mercury.

Pending seizure and economic exploitation of the oil and bauxite resources of the southern area, stock piling of these vital materials was a necessity. By the end of 1941, bauxite stocks of 250,000 tons, constituting a 7 months' supply, and 43,000,000 barrels of oil and oil products were stored in Japan.

Considering the economic performance of the decade, one cannot but be impressed by the intensity of the effort and the magnitude of the results. Nonetheless, Japan remained with an economy having approximately 10 percent of the potential of the United States economy. It was desperately vulnerable to attack on its shipping. Having a comparatively small, newly developed industry, it had to work without much cushion of under-utilized physical plant capacity. Having had little experience with mass production, the country had no opportunity to build up a large force of industrially and mechanically trained personnel. This meant

shortages of skills, ingenuity and ability to improvise later on, when the economy was under the stresses and strains of large-scale warfare.

This economic potential could support a short war or a war of limited liabilities. The accumulated stocks of munitions, oil, planes and ships could be thrown into action and produce a devastating effect on unmobilized enemies. When this initial blow failed to result in peace, Japan, without significant help from Germany, was doomed. Its economy could not support a protracted campaign against an enemy even half as strong as the United States.

In addition, the success of the initial Japanese military operations delayed total economic mobilization until after the defeats of late 1942. Computed in constant prices, the gross national product rose from a level of 39.8 billion yen in the fiscal year beginning with April 1940, to only 41 billion yen in the fiscal year 1942. That this was due to an inadequate realization of requirements and inadequate planning, and not to the inherent limitations of the Japanese economy, is clear from the expansion that was secured after 1942. In the fiscal year 1943, the gross national product rose to 45.4 billion yen, and in 1944 to 50 billion yen.

The share of the gross national product devoted to direct war and munitions expenditures increased from 23 percent in 1941 to 31 percent in 1942, 42 percent in 1943 and 52 percent in 1944. In 1944, half of the remaining national product was accounted for by food. In 1943, however, the United States was devoting 45 percent of its vastly greater national product to direct war purposes. By the summer of 1944, the Japanese had exhausted the possibility of forcing a greater share of their economy into direct war activities. Their plants, railroad and mines were being, and had been for some time, under-maintained to a point where breakdowns were becoming more and more serious. The civilian population was underfed, was receiving practically no new clothing or miscellaneous civilian supplies, and was being worked to a degree of fatigue which was reflected in rising rates of absenteeism.

By 1944, Japan had increased ingot steel capacity to 225 percent of the 1937 capacity. A shortage of raw materials, however, which

began with the United States embargo on scrap iron exports in July 1941 and was never overcome, prevented the operation of Japanese steel mills at anything approaching capacity. Japanese coal would not produce satisfactory metallurgical coke without the admixture of stronger continental coking coal; domestic iron ore was both limited in quantity and of lower grade than imported ores. The combination of limited quantities of high-grade imported raw materials and lower grade domestic materials held production of ingot steel in the home islands to 6,800,000 tons in 1941, to a peak of 7,800,000 tons in 1943, and caused it to decline to 5,900,000 tons in 1944. This compared with a 1937 production of 5,800,000 tons and a theoretical capacity, using high-grade materials, of 13,600,000 tons in 1944. By the middle of 1944, the increasing stringency of shipping and the interdiction of many of Japan's shipping routes had reduced coal and ore imports by two-thirds. Stockpiles of imported materials had already been heavily eaten into, and ingot steel production began to decline rapidly. In March 1945, imports of coal virtually ceased, and iron ore was cut off entirely, as the Japanese elected to devote their remaining shipping capacity to the hauling of vitally needed foodstuffs and salt. It is estimated by the Survey that, using only domestic raw materials, the Japanese steel industry could not have maintained a rate of production of ingot steel in excess of 1,500,000 tons per annum. By August 1945, the rate of output was still somewhat in excess of this figure, but would soon have been reduced. The decline in Japan's steel production can be attributed to its dependence on shipping and the destruction of that shipping. Had this industry not been mortally wounded by shipping attack and had its destruction by bombing been called for, the effectiveness of the few strategic bombing attacks directed against the steel industry indicates that destruction of the principal plants by bombing or paralysis of the industry by disruption of railroad transportation would have been possible, but only at a later date.

The steel shortage constituted an over-all limitation on the war potential of the Japanese economy. Japanese planners were,

however, able to secure very substantial increases in the production of those military products which the experiences of the war had demonstrated to be of outstanding importance. Aircraft production of all types, including training planes, was stepped up from 700 planes per month in the summer of 1942 to 2,572 planes in September 1944. Aircraft engine production was not only increased correspondingly in numbers, but average horsepower was doubled. Aircraft and antiaircraft gun and ammunition production was expanded tenfold. Radar and communications equipment was stepped up fivefold. The most important consumer of steel was the shipbuilding industry. The increasingly critical nature of Japan's shipping situation caused her to expand her naval and merchant shipbuilding programs to a point where 35 percent of all steel consumed was being used in that industry alone. Construction of merchant ships increased from approximately 238,000 tons in 1941, to 1,600,000 tons of steel ships and 254,000 tons of wooden ships in 1944. During 1942, warship deliveries included one battleship of 64,000 tons and six small carriers totalling 84,000 tons. In 1944, no battleships, but four aircraft carriers of 114,500 displacement tons and 141,300 tons of escort vessels and submarines were delivered. The increases in production of high-priority items involved the scaling down of steel availability for lower priority items, such as tanks, larger caliber guns and trucks, and the almost complete elimination of steel for civilian requirements, construction, or export.

During 1944, the effects of the net loss of shipping and slow-down in ship operations became such that by the end of the year it no longer was possible to protect even high-priority war production by further shifting of allocations of scarce materials from items of lesser priority. In addition to steel, other basic elements of the economy were involved. Oil, although not as important as steel in its broad impact on the remainder of the economy, was of critical importance to Japan's military machine and to her merchant marine. Oil imports from the south began declining in August 1943, and had been eliminated by April 1945. Crude oil stocks

were virtually exhausted; refinery operations had to be curtailed; and stocks of aviation gasoline fell to less than 1,500,000 barrels, a point so low as to require a drastic cut in the pilot-training program and even in combat air missions. Bauxite imports declined from 136,000 tons in the second quarter of 1944, to 30,000 tons in the third, and stockpiles were only 3,000 tons. Stockpiles and the time delay between the various stages of production cushioned for a time the inevitable effects of the blockade on finished munitions production, but by November 1944, the over-all level of Japanese war production had begun to turn down, including even the highest priority items, such as aircraft engines.

It is the opinion of the Survey that by August 1945, even without direct air attack on her cities and industries, the over-all level of Japanese war production would have declined below the peak levels of 1944 by 40 to 50 percent solely as a result of the interdiction of overseas imports.

By mid-1944 those Japanese in possession of the basic information saw with reasonable clarity the economic disaster which was inevitably descending on Japan. Furthermore, they were aware of the disastrous impact of long-range bombing on Germany, and, with the loss of the Marianas, could foresee a similar attack on Japan's industries and cities. Their influence, however, was not sufficient to overcome the influence of the Army which was confident of its ability to resist invasion.

The Air Attack Against the Japanese Home Islands

Basic United States strategy contemplated that the final decision in the Japanese war would be obtained by an invasion of the Japanese home islands. The long-range bombing offensive from the Marianas was initiated in November 1944, with that in mind as the primary objective. As in Europe prior to D-day, the principal measure of success set for strategic air action was the extent to

which it would weaken enemy capability and will to resist our amphibious forces at the time of landings. This led, originally, to somewhat greater emphasis on the selection of targets such as aircraft factories, arsenals, electronics plants, oil refineries, and finished military goods, destruction of which could be expected to weaken the capabilities of the Japanese armed forces to resist at the Kyushu beachheads in November 1945, than on the disruption of the more basic elements of Japan's social, economic, and political fabric. Certain of the United States commanders and the representatives of the Survey who were called back from their investigations in Germany in early June 1945 for consultation stated their belief that, by the coordinated impact of blockade and direct air attack, Japan could be forced to surrender without invasion. The controlling opinion, however, was that any estimate of the effects of bombing on the Japanese social fabric and on the political decisions of those in control of Japan was bound to be so uncertain that target selection could safely be made only on the assumption that ground force invasion would be necessary to force capitulation.

With the benefit of hindsight, it appears that the twin objectives of surrender without invasion and reduction of Japan's capacity and will to resist an invasion, should the first not succeed, called for basically the same type of attack. Japan had been critically wounded by military defeats, destruction of the bulk of her merchant fleet, and almost complete blockade. The proper target, after an initial attack on aircraft engine plants, either to bring overwhelming pressure on her to surrender, or to reduce her capability of resisting invasion, was the basic economic and social fabric of the country. Disruption of her railroad and transportation system by daylight attacks, coupled with destruction of her cities by night and bad weather attacks, would have applied maximum pressure in support of either aim. This point of view was finally adopted. Although urban area attacks were initiated in force in March 1945, the railroad attack was just getting under way when the war ended.

The total tonnage of bombs dropped by Allied planes in the Pacific war was 656,400. Of this, 160,800 tons, or 24 percent, were dropped on the home islands of Japan. Navy aircraft accounted for 6,800 tons, Army aircraft other than B–29s for 7,000 tons, and the B–29s for 147,000 tons. By contrast, the total bomb tonnage in the European theater was 2,700,000 tons of which 1,360,000 tons were dropped within Germany's own borders.

Approximately 800 tons of bombs were dropped by China-based B–29s on Japanese home island targets from June 1944 to January 1945. These raids were of insufficient weight and accuracy to produce significant results.

By the end of November 1944, 4 months after seizure of the islands, the first of the long-range bomber bases in the Marianas became operational. The number of planes originally available was small and opposition was significant. Losses on combat missions averaged 3.6 percent. The tonnage dropped prior to 9 March 1945 aggregated only 7,180 tons although increasing month by month. The planes bombed from approximately 30,000 feet and the percentage of bombs dropped which hit the target areas averaged less than 10 percent. Nevertheless, the effects of even the relatively small tonnage hitting the selected targets were substantial. During this period, attacks were directed almost exclusively against aircraft, primarily aircraft engine, targets. The principal aircraft engine plants were hit sufficiently heavily and persistently to convince the Japanese that these plants would inevitably be totally destroyed. The Japanese were thereby forced into a wholesale and hasty dispersal program. The continuing pressure of immediate military requirements for more and more planes during the campaigns in the Pacific had prevented any earlier moves to disperse. When dispersal could no longer be avoided, the necessary underground tunnels, dispersed buildings, and accessory facilities such as roads, railroad spurs and power connections were not ready. As a result the decline in aircraft engine production, which shortages in special steels requiring cobalt, nickel and chrome had initiated in mid-1944, became precipitous.

On 9 March 1945, a basic revision in the method of B–29 attack was instituted. It was decided to bomb the four principal Japanese cities at night from altitudes averaging 7,000 feet. Japanese weakness in night fighters and antiaircraft made this program feasible. Incendiaries were used instead of high-explosive bombs and the lower altitude permitted a substantial increase in bomb load per plane. One thousand six hundred and sixty-seven tons of bombs were dropped on Tokyo in the first attack. The chosen areas were saturated. Fifteen square miles of Tokyo's most densely populated area were burned to the ground. The weight and intensity of this attack caught the Japanese by surprise. No subsequent urban area attack was equally destructive. Two days later, an attack of similar magnitude on Nagoya destroyed 2 square miles. In a period of 10 days starting 9 March, a total of 1,595 sorties delivered 9,373 tons of bombs against Tokyo, Nagoya, Osake, and Kobe destroying 31 square miles of those cities at a cost of 22 airplanes. The generally destructive effect of incendiary attacks against Japanese cities had been demonstrated.

Thereafter, urban area attacks alternated with visual and radar attacks against selected industrial or military targets. In April, an extensive program of sowing minefields in channels and harbors at night was added. In the aggregate, 104,000 tons of bombs were directed at 66 urban areas; 14,150 tons were directed at aircraft factories; 10,600 tons at oil refineries; 4,708 at arsenals; 3,500 tons at miscellaneous industrial targets; 8,115 tons at air fields and seaplane bases in support of the Okinawa operation; and 12,054 mines were sown.

Bombing altitudes after 9 March 1945 were lower, in both day and night attacks. Japanese opposition was not effective even at the lower altitudes, and the percentage of losses to enemy action declined as the number of attacking planes increased. Bomb loads increased and operating losses declined in part due to less strain on engines at lower altitudes. Bombing accuracy increased substantially, and averaged 35 to 40 percent within 1,000 feet of the aiming point in daylight attacks from 20,000 feet or lower.

Monthly tonnage dropped increased from 13,800 tons in March to 42,700 tons in July, and, with the activation of the Eighth Air Force on Okinawa, would have continued to increase thereafter to a planned figure of 115,000 tons per month, had the war not come to an end.

Three-quarters of the 6,740 tons of bombs dropped by carrier planes on the Japanese home islands were directed against airfields, warships, and miscellaneous military targets, and one-quarter against merchant shipping and other economic targets. Most of the warships sunk in home ports had already been immobilized for lack of fuel. The accuracy of low-level carrier plane attack was high, being at least 50 percent hits within 250 feet of the aiming point. The attack against the Hakodate-Aomori rail ferries in July 1945 sank or damaged all twelve of the ferries, 17 steel ships, and 149 smaller ships.

Economic Effects of Air Attack Against the Japanese Home Islands

The physical destruction resulting from the air attack on Japan approximates that suffered by Germany, even though the tonnage of bombs dropped was far smaller. The attack was more concentrated in time, and the target areas were smaller and more vulnerable. Not only were the Japanese defenses overwhelmed, but Japan's will and capacity for reconstruction, dispersal, and passive defense were less than Germany's. In the aggregate some 40 percent of the built-up area of the 66 cities attacked was destroyed. Approximately 30 percent of the entire urban population of Japan lost their homes and many of their possessions. The physical destruction of industrial plants subjected to high-explosive attacks was similarly impressive. The larger bomb loads of the B–29s permitted higher densities of bombs per acre in the plant area, and on the average somewhat heavier bombs were used. The destruction was generally more complete than in Germany. Plants

specifically attacked with high-explosive bombs were, however, limited in number.

The railroad system had not yet been subjected to substantial attack and remained in reasonably good operating condition at the time of surrender. Little damage was suffered which interfered with main line operations. Trains were running through Hiroshima 48 hours after the dropping of the atomic bomb on that city. Damage to local transport facilities, however, seriously disrupted the movement of supplies within and between cities, thereby hindering production, repair work and dispersal operations.

Japan's electric power system was properly rejected for specific attack because of the large number of small targets presented. Urban incendiary attacks destroyed the electric distribution systems in the burned-out areas simultaneously with the consumer load previously served by them. The hydro-electric generating plants and the transmission networks survived without substantial damage. Twenty-six urban steam-generating plants were damaged as an incident to other attacks, the aggregate loss of capacity being less than one-seventh of Japan's total generating capacity.

The urban area incendiary attacks eliminated completely the residential and smaller commercial and industrial structures in the affected areas and a significant number of important plants, but a portion of the more substantially constructed office buildings and factories in those areas and the underground utilities survived. By 1944 the Japanese had almost eliminated home industry in their war economy. They still relied, however, on plants employing less than 250 workers for subcontracted parts and equipment. Many of these smaller plants were concentrated in Tokyo and accounted for 50 percent of the total industrial output of the city. Such plants suffered severe damage in urban incendiary attacks.

Four hundred and seventy thousand barrels of oil and oil products, 221,000 tons of foodstuffs and 2 billion square yards of textiles were destroyed by air attacks. Ninety-seven percent of Japan's stocks of guns, shells, explosives, and other military supplies were thoroughly protected in dispersed or underground storage depots, and were not vulnerable to air attack.

Physical damage to plant installations by either area or precision attacks, plus decreases due to dispersal forced by the threat of further physical damage, reduced physical productive capacity by roughly the following percentages of pre-attack plant capacity: oil refineries, 83 percent; aircraft engine plants, 75 percent; air-frame plants, 60 percent; electronics and communication equipment plants, 70 percent; army ordnance plants, 30 percent; naval ordnance plants, 28 percent; merchant and naval shipyards, 15 percent; light metals, 35 percent; ingot steel, 15 percent; chemicals, 10 percent.

The economic consequences of the physical damage wrought by air attack are closely interrelated with the concurrent effects of the interdiction of imports, the cumulative effects of under-maintenance of plants, and the declining health, vigor and determination of the Japanese people.

Let us first consider the level of Japanese industrial activity in July 1945, the last full month before surrender. Electric power and coal consumption were both almost exactly 50 percent of the peak reached in 1944. Production efficiency had, however, declined and the overall industrial output was approximately 40 percent of the 1944 peak. Output varied considerably as between industries, hit and unhit plants, and by areas. Output of air frame was 40 percent of the 1944 peak; aircraft engines, 25 percent; shipbuilding, 25 percent; army ordnance, 45 percent; and naval ordnance, 43 percent. Oil refining had declined to less than 15 percent of the 1943 output. Primary aluminum production was 9 percent of the 1944 peak. Although nitric acid production had declined to about 17 percent of the 1944 peak, explosives production was about 45 percent of the 1944 figure.

In each one of these industries, the occasion for the decline appears to have been different. Electric power consumption fell, not because more power was not available, but because demand had declined. Coal supply was primarily limited by the decline in inter-island shipping from Hokkaido and Kyushu, and the inability of the railroad system completely to fill the gap. Despite a decline

in demand, shortages of coal were universal throughout the economy. Airframe production was limited primarily by the continuing effects of the dispersal program brought on by the initial bombing, and aggravated by the subsequent destruction of numerous plants prior to completion of dispersal. Had the level of production been any higher, however, aluminum stocks would have been exhausted and aluminum would have become the controlling bottleneck. In any event, not enough aircraft engines were being produced to equip the airframes. Aircraft engine production was plagued by shortages of special steels, but in July 1945, plant damage and delay in completing the underground and dispersed plants started in the spring of the year temporarily prevented the full use of the small stocks of such steels available at the time. Output of radar and radio equipment was limited by plant capacity, the small factories supplying parts having been destroyed in the Tokyo city raids and many of the larger plants either destroyed or forced to disperse. Shipbuilding and heavy ordnance production were limited by the availability of steel. Oil refineries, aluminum plants and steel plants were basically limited by lack of foreign raw materials. Explosive plants were still using up inventories of nitric acid but would shortly have had to adjust their output to the current availability of nitric acid.

The Japanese labor force had declined in efficiency due to malnutrition and fatigue, the destruction of much of the urban housing and the difficulties of local transportation. Production hours lost through all causes including absenteeism, sickness, air-raid alerts and enforced idleness rose from 20 percent in 1944 to over 40 percent in July 1945. The size of the labor force employed did not materially decline and the productive hours actually worked remained sufficiently high to indicate that such influence as manpower deficiencies may have had on the over-all level of production in July 1945, was largely ascribable to the continued drafting of highly skilled workers into the armed services and to the inefficient administration of manpower in meeting the rapidly shifting requirements resulting from bombing, rather than to over-all lack of labor.

A Survey investigation of production in plants employing more than 50 employees in 39 representative cities of Japan indicates that production in those plants which suffered any direct physical damage dropped off by July 1945, to 27 percent of peak output in 1944, while production in the undamaged plants fell off to 54 percent. Production in all plants in the sample, including both hit and unhit, dropped to 35 percent of peak by July 1945. It appears probable that the indirect effects of the urban raids through increased absenteeism, disruption of supply lines and administrative confusion fully compensate for diversions of manpower and material from hit to unhit plants. The difference between 54 percent, being the rate of production in unhit plants, and 35 percent, being the average for all plants, is, therefore, a conservative indication of the impact of air attacks, both urban and precision, on production in these cities.

Even though the urban area attacks and attacks on specific industrial plants contributed a substantial percentage to the over-all decline in Japan's economy, in many segments of that economy their effects were duplicative. Most of the oil refineries were out of oil, the alumina plants out of bauxite, the steel mills lacking in ore and coke, and the munitions plants low in steel and aluminum. Japan's economy was in large measure being destroyed twice over, once by cutting off of imports, and secondly by air attack. A further tightening of Japan's shipping situation, so as to eliminate remaining imports from Korea and coastwise and inter-island shipping, coupled with an attack on Japan's extremely vulnerable railroad network, would have extended and cumulated the effects of the shipping attack already made.

Much of Japan's coastal and inter-island traffic had already been forced on to her inadequate railroads. The principal coal mines of Japan are located on Kyushu and Hokkaido. This coal traffic, formerly water borne, was moving by railroads employing the Kanmon tunnels and the Hakkodate-Aomori rail ferry. The railroads on Honshu include few main lines and these lines traverse bridges of considerable vulnerability. Japan is largely a

mountainous country lacking automobile roads, trucks or the gasoline to make use of them. A successful attack on the Hakkodate rail ferry, the Kanmon tunnels and 19 bridges and vulnerable sections of line so selected as to set up five separate zones of complete interdiction would have virtually eliminated further coal movements, would have immobilized the remainder of the rail system through lack of coal, and would have completed the strangulation of Japan's economy. This strangulation would have more effectively and efficiently destroyed the economic structure of the country than individually destroying Japan's cities and factories. It would have reduced Japan to a series of isolated communities, incapable of any sustained industrial production, incapable of moving food from the agricultural areas to the cities, and incapable of rapid large-scale movements of troops and munitions.

The Survey believes that such an attack, had it been well-planned in advance, might have been initiated by carrier-based attacks on shipping and on the Hakkodate ferry in August 1944, could have been continued by aerial mining of inland waterways beginning in December 1944, and could have been further continued by initiating the railroad attack as early as April 1945. The Survey has estimated that force requirements to effect complete interdiction of the railroad system would have been 650 B–29 visual sorties carrying 5,200 tons of high explosive bombs. Monthly tonnages equal to one and one-half times that required to effect the original interdiction should have been sufficient, in view of the Japanese lack of preparation and slowness in effecting repairs, to maintain the interdiction by destroying such bridges and other facilities as the Japanese were able to repair. The use of Azon guided bombs, which could have been made available at that time, would have greatly increased accuracy against targets of this type and reduced force requirements to approximately one-sixth of those given above. An integrated program employing both carrier planes and B–29s would have capitalized on the differing operational capabilities of each.

The economic effects of the transportation attack would have had a direct impact on the Japanese people and on their determination to continue the war. In order to bring maximum pressure on the civilian population and to complicate further the Japanese economic problems, night and bad weather attacks on urban areas could have been carried out simultaneously with the transportation attack. One of the important factors inducing Japan's leaders to accept unconditional surrender was a realization that the Japanese armed forces had lost their ability to protect the people and that under the impact of direct air attack and lowered livelihood their confidence in victory and determination to continue the war were rapidly declining.

The Health and Morale of the Japanese Civilian Population Under Assault

Total civilian casualties in Japan, as a result of 9 months of air attack, including those from the atomic bombs, were approximately 806,000. Of these, approximately 330,000 were fatalities. These casualties probably exceeded Japan's combat casualties which the Japanese estimate as having totaled approximately 780,000 during the entire war. The principal cause of civilian death or injury was burns. Of the total casualties approximately 185,000 were suffered in the initial attack on Tokyo of 9 March 1945. Casualties in many extremely destructive attacks were comparatively low. Yokohama, a city of 900,000 population, was 47 percent destroyed in a single attack lasting less than an hour. The fatalities suffered were less than 5,000.

The Japanese had constructed extensive firebreaks by tearing down all houses along selected streets or natural barriers. The total number of buildings torn down in this program, as reported by the Japanese, amounted to 615,000 as against 2,510,000 destroyed by the air attacks themselves. These firebreaks did not effectively stop the spread of fire, as incendiaries were dropped on both sides of the

breaks. They did, however, constitute avenues of escape for the civilian population.

The Japanese instituted a civilian-defense organization prior to the war. It was not until the summer of 1944, however, that effective steps were taken to reduce the vulnerability of Japan's civilian population to air attacks. By that time, the shortage of steel, concrete and other construction materials was such that adequate air-raid shelters could no longer be built. Each family was given the obligation of providing itself with some kind of an excavation covered with bamboo and a little dirt. In addition, tunnels were dug into the sides of hills wherever the topography permitted.

Japanese planning and the means for carrying out the plans were thus deficient for a first-class civilian defense program. In spite of these limitations, such civilian defense measures as they were able to put through contributed substantially in minimizing casualties. School children and other nonessential urban dwellers were evacuated to the country. Those who remained were organized to combat fires and to provide mutual assistance. The air raid warning system was generally efficient. The weight of the individual attacks was, however, far heavier than the Japanese had envisaged or were able to cope with. In the major fire attacks, the civilian defense organizations were simply overwhelmed.

The growing food shortage was the principal factor affecting the health and vigor of the Japanese people. Prior to Pearl Harbor the average per capita caloric intake of the Japanese people was about 2,000 calories as against 3,400 in the United States. The acreage of arable land in Japan is only 3 percent of that of the United States to support a population over half as large. In order to provide the prewar diet, this arable acreage was more intensively cultivated, using more manpower and larger quantities of fertilizer, than in any other country in the world; fishing was developed into a major industry; and rice, soybeans and other foodstuffs amounting to 19 percent of the caloric intake were imported. Despite the rationing of food beginning in April 1941, the food situation became critical.

As the war progressed, imports became more and more difficult, the waters available to the fishing fleet and the ships and fuel oil for its use became increasingly restricted. Domestic food production itself was affected by the drafting of the younger males and by an increasing shortage of fertilizers.

By 1944, the average per capita caloric intake had declined to approximately 1,900 calories. By the summer of 1945 it was about 1,680 calories per capita. Coal miners and heavy industrial workers received higher-than-average rations, the remaining populace, less. The average diet suffered even more drastically from reductions in fats, vitamins and minerals required for balance and adversely affected rates of recovery and mortality from disease and bomb injuries.

Undernourishment produced a major increase in the incidence of beriberi and tuberculosis. It also had an important effect on the efficiency and morale of the people, and contributed to absenteeism among workers.

Survey interrogation of a scientifically designed cross-section sample of the Japanese civilian population revealed a high degree of uniformity as between city and rural sectors of the population and as between various economic and social strata in their psychological reaction to the war. A uniformly high percentage considered Japan's greatest weaknesses to have been in the material realm, either lack of resources, productive plant or modern weapons, and her greatest strength to have been in the Yamato spirit of the Japanese people, their willingness to make every personal sacrifice, including that of life itself, for the Emperor or Japan.

The Japanese people reacted to news of the attack against the United States and its Allies with mingled feelings of fear, insecurity and hope. To a people wearied by 10 years of war in China, it was clear that this would be a major war and not an "incident." The early Japanese military successes, particularly the capture of Singapore and the southern regions, were followed by a wave of optimism and high confidence. Subsequent defeats were studiously

withheld from the people or disguised as strategic withdrawals. Prior to the loss of Saipan confidence in eventual victory remained high in spite of exhausting work, poor nutrition and rising black market prices. In June 1944 approximately two percent of the population believed that Japan faced the probability of defeat. The fall of Saipan could not be kept from the Japanese people. Even though the psychological effect of this disaster was far greater on the Japanese leaders and intellectuals than on the mass of the population, all indices of Japanese morale began thereafter to decline. By December 1944 air attacks from the Marianas against the home islands had begun, defeats in the Philippines had been suffered, and the food situation had deteriorated; 10 percent of the people believed Japan could not achieve victory. By March 1945, when the night incendiary attacks began and the food ration was reduced, this percentage had risen to 19 percent. In June it was 46 percent, and just prior to surrender, 68 percent. Of those who had come to this belief over one-half attributed the principal cause to air attacks, other than the atomic bombing attacks, and one-third to military defeats.

Sixty-four percent of the population stated that they had reached a point prior to surrender where they felt personally unable to go on with the war. Of these, less than one-tenth attributed the cause to military defeats, one-quarter attributed the cause to shortages of food and civilian supplies, the largest part to air attack.

A striking aspect of the air attack was the pervasiveness with which its impact on morale blanketed Japan. Roughly one-quarter of all people in cities fled or were evacuated, and these evacuees, who themselves were of singularly low morale, helped spread discouragement and disaffection for the war throughout the islands. This mass migration from the cities included an estimated 8,500,000 persons. Throughout the Japanese islands, whose people had always thought themselves remote from attack, United States planes crisscrossed the skies with no effective Japanese air or antiaircraft opposition. That this was an indication of impending defeat became as obvious to the rural as to the urban population.

Progressively lowered morale was characterized by loss of faith in both military and civilian leaders, loss of confidence in Japan's military might and increasing distrust of government news releases and propaganda. People became short-tempered and more outspoken in their criticism of the government, the war and affairs in general. Until the end, however, national traditions of obedience and conformity, reinforced by the police organization, remained effective in controlling the behavior of the population. The Emperor largely escaped the criticism which was directed at other leaders, and retained the people's faith in him. It is probable that most Japanese would have passively faced death in a continuation of the hopeless struggle, had the Emperor so ordered. When the Emperor announced the unconditional surrender the first reaction of the people was one of regret and surprise, followed shortly by relief.

The interrelation of military, economic and morale factors was complex. To a certain extent each reacted on the other. In the final analysis the Japanese military machine had lost its purpose when it could no longer protect the Japanese people from destruction by air attack. General Takashima, when asked by the Survey as to his reaction to the Imperial Rescript, stated that surrender had become unavoidable; the Army, even should it repel invasion, could no longer protect the Japanese people from extermination.

The Effects of the Atomic Bombs

On 6 August and 9 August 1945, the first two atomic bombs to be used for military purposes were dropped on Hiroshima and Nagasaki respectively. One hundred thousand people were killed, 6 square miles or over 50 percent of the built-up areas of the two cities were destroyed. The first and crucial question about the atomic bomb thus was answered practically and conclusively; atomic energy had been mastered for military purposes and the overwhelming scale of its possibilities had been demonstrated. A detailed examination of the physical, economic, and morale effects

of the atomic bombs occupied the attention of a major portion of the Survey's staff in Japan in order to arrive at a more precise definition of the present capabilities and limitations of this radically new weapon of destruction.

Eyewitness accounts of the explosion all describe similar pictures. The bombs exploded with a tremendous flash of blue-white light, like a giant magnesium flare. The flash was of short duration and accompanied by intense glare and heat. It was followed by a tremendous pressure wave and the rumbling sound of the explosion. This sound is not clearly recollected by those who survived near the center of the explosion, although it was clearly heard by others as much as fifteen miles away. A huge snow-white cloud shot rapidly into the sky and the scene on the ground was obscured first by a bluish haze and then by a purple-brown cloud of dust and smoke.

Such eyewitness accounts reveal the sequence of events. At the time of the explosion, energy was given off in the forms of light, heat, radiation, and pressure. The complete band of radiations, from X- and gamma-rays, through ultraviolet and light rays to the radiant heat of infra-red rays, travelled with the speed of light. The shock wave created by the enormous pressures built up almost instantaneously at the point of explosion but moved out more slowly, that is at about the speed of sound. The superheated gases constituting the original fire ball expanded outward and upward at a slower rate.

The light and radiant heat rays accompanying the flash travelled in a straight line and any opaque object, even a single leaf of a vine, shielded objects lying behind it. The duration of the flash was only a fraction of a second, but it was sufficiently intense to cause third degree burns to exposed human skin up to a distance of a mile. Clothing ignited, though it could be quickly beaten out, telephone poles charred, thatchroofed houses caught fire. Black or other dark-colored surfaces of combustible material absorbed the heat and immediately charred or burst into flames; white or light-colored surfaces reflected a substantial portion of the rays and were not

consumed. The heavy black clay tiles which are an almost universal feature of the roofs of Japanese houses bubbled at distances up to a mile. Test of samples of this tile by the National Bureau of Standards in Washington indicates that temperatures in excess of 1,800° C. must have been generated in the surface of the tile to produce such an effect. The surfaces of granite blocks exposed to the flash scarred and spalled at distances up to almost a mile. In the immediate area of ground zero (the point on the ground immediately below the explosion), the heat charred corpses beyond recognition.

Penetrating rays such as gamma-rays exposed X-ray films stored in the basement of a concrete hospital almost a mile from ground zero. Symptoms of their effect on human beings close to the center of the explosion, who survived other effects thereof, were generally delayed for two or three days. The bone marrow and as a result the process of blood formation were affected. The white corpuscle count went down and the human processes of resisting infection were destroyed. Death generally followed shortly thereafter.

The majority of radiation cases who were at greater distances did not show severe symptoms until 1 to 4 weeks after the explosion. The first symptoms were loss of appetite, lassitude and general discomfort. Withinin 12 to 48 hours, fever became evident in many cases, going as high as 104° to 105° F., which in fatal cases continued until death. If the fever subsided, the patient usually showed a rapid disappearance of other symptoms and soon regained his feeling of good health. Other symptoms were loss of white blood corpuscles, loss of hair, and decrease in sperm count.

Even though rays of this nature have great powers of penetration, intervening substances filter out portions of them. As the weight of the intervening material increases the percentage of the rays penetrating goes down. It appears that a few feet of concrete, or a somewhat greater thickness of earth, furnished sufficient protection to humans, even those close to ground zero, to prevent serious after effects from radiation.

The blast wave which followed the flash was of sufficient force to press in the roofs of reinforced-concrete structures and to flatten

completely all less sturdy structures. Due to the height of the explosion, the peak pressure of the wave at ground zero was no higher than that produced by a near-miss of a high-explosive bomb, and decreased at greater distances from ground zero. Reflection and shielding by intervening hills and structures produced some unevenness in the pattern. The blast wave, however, was of far greater extent and duration than that of a high-explosive bomb and most reinforced-concrete structures suffered structural damage or collapse up to 700 feet at Hiroshima and 2,000 feet at Nagasaki. Brick buildings were flattened up to 7,300 feet at Hiroshima and 8,500 feet at Nagasaki. Typical Japanese houses of wood construction suffered total collapse up to approximately 7,300 feet at Hiroshima and 8,200 feet at Nagasaki. Beyond these distances structures received less serious damage to roots, wall partitions, and the like. Glass windows were blown out at distances up to 5 miles. The blast wave, being of longer duration than that caused by high-explosive detonations, was accompanied by more flying debris. Window frames, doors, and partitions which would have been shaken down by a near-miss of a high-explosive bomb were hurled at high velocity through those buildings which did not collapse. Machine tools and most other production equipment in industrial plants were not directly damaged by the blast wave, but were damaged by collapsing buildings or ensuing general fire.

The above description mentions all the categories of the destructive action by the atomic-bomb explosions at Hiroshima and Nagasaki. There were no other types of action. Nothing was vaporized or disintegrated; vegetation is growing again immediately under the center of the explosions; there are no indications that radio-activity continued after the explosion to a sufficient degree to harm human beings.

Let us consider, however, the effect of these various types of destructive action on the cities of Hiroshima and Nagasaki and their inhabitants.

Hiroshima is built on a broad river delta; it is flat and little above sea level. The total city area is 26 square miles but only 7 square

miles at the center were densely built up. The principal industries, which had been greatly expanded during the war, were located on the periphery of the city. The population of the city had been reduced from approximately 340,000 to 245,000 as a result of a civilian defense evacuation program. The explosion caught the city by surprise. An alert had been sounded but in view of the small number of planes the all-clear had been given. Consequently, the population had not taken shelter. The bomb exploded a little northwest of the center of the built-up area. Everyone who was out in the open and was exposed to the initial flash suffered serious burns where not protected by clothing. Over 4 square miles in the center of the city were flattened to the ground with the exception of some 50 reinforced concrete buildings, most of which were internally gutted and many of which suffered structural damage. Most of the people in the flattened area were crushed or pinned down by the collapsing buildings or flying debris. Shortly thereafter, numerous fires started, a few from the direct heat of the flash, but most from overturned charcoal cooking stoves or other secondary causes. These fires grew in size, merging into a general conflagration fanned by a wind sucked into the center of the city by the rising heat. The civilian-defense organization was overwhelmed by the completeness of the destruction, and the spread of fire was halted more by the air rushing toward the center of the conflagration than by efforts of the fire-fighting organization.

Approximately 60,000 to 70,000 people were killed, and 50,000 were injured. Of approximately 90,000 buildings in the city, 65,000 were rendered unusable and almost all the remainder received at least light superficial damage. The underground utilities of the city were undamaged except where they crossed bridges over the rivers cutting through the city. All of the small factories in the center of the city were destroyed. However, the big plants on the periphery of the city were almost completely undamaged and 94 percent of their workers unhurt. These factories accounted for 74 percent of the industrial production of the city. It is estimated that they could have resumed substantially normal production within 30

days of the bombing, had the war continued. The railroads running through the city were repaired for the resumption of through traffic on 8 August, 2 days after the attack.

Nagasaki was a highly congested city built around the harbor and up into the ravines and river valleys of the surrounding hills. Spurs of these hills coming down close to the head of the bay divide the city roughly into two basins. The built-up area was 3.4 square miles of which 0.6 square miles was given over to industry. The peak wartime population of 285,000 had been reduced to around 230,000, by August 1945, largely by pre-raid evacuations. Nagasaki had been attacked sporadically prior to 9 August by an aggregate of 136 planes which dropped 270 tons of high explosives and 53 tons of incendiary bombs. Some 2 percent of the residential buildings had been destroyed or badly damaged; three of the large industrial plants had received scattered damage. The city was thus comparatively intact at the time of the atomic bombing.

The alarm was improperly given and therefore few persons were in shelters. The bomb exploded over the northwest portion of the city; the intervening hills protected a major portion of the city lying in the adjoining valley. The heat radiation and blast actions of the Nagasaki bomb were more intense than those of the bomb dropped over Hiroshima. Reinforced-concrete structures were structurally damaged at greater distances; the heavy steel-frame industrial buildings of the Mitsubishi steel works and the arms plant were pushed at crazy angles away from the center of the explosion. Contrary to the situation at Hiroshima, the majority of the fires that started immediately after the explosion resulted from direct ignition by the flash.

Approximately 40,000 persons were killed or missing and a like number injured. Of the 52,000 residential buildings in Nagasaki 14,000 were totally destroyed and a further 5,400 badly damaged. Ninety-six percent of the industrial output of Nagasaki was concentrated in the large plants of the Mitsubishi Co. which completely dominated the town. The arms plant and the steel works were located within the area of primary damage. It is estimated that

58 percent of the yen value of the arms plant and 78 percent of the value of the steel works were destroyed. The main plant of the Mitsubishi electric works was on the periphery of the area of greatest destruction. Approximately 25 percent of its value was destroyed. The dockyard, the largest industrial establishment in Nagasaki and one of the three plants previously damaged by high-explosive bombs, was located down the bay from the explosion. It suffered virtually no new damage. The Mitsubishi plants were all operating, prior to the attack, at a fraction of their capacity because of a shortage of raw materials. Had the war continued, and had the raw material situation been such as to warrant their restoration, it is estimated that the dockyard could have been in a position to produce at 80 percent of its full capacity within 3 to 4 months; that the steel works would have required a year to get into substantial production; that the electric works could have resumed some production within 2 months and been back at capacity within 6 months; and that restoration of the arms plant to 60 to 70 percent of former capacity would have required 15 months.

Some 400 persons were in the tunnel shelters in Nagasaki at the time of the explosion. The shelters consisted of rough tunnels dug horizontally into the sides of hills with crude, earth-filled blast walls protecting the entrances. The blast walls were blown in but all the occupants back from the entrances survived, even in those tunnels almost directly under the explosion. Those not in a direct line with the entrance were uninjured. The tunnels had a capacity of roughly 100,000 persons. Had the proper alarm been sounded, and these tunnel shelters been filled to capacity, the loss of life in Nagasaki would have been substantially lower.

The Survey has estimated that the damage and casualties caused at Hiroshima by the one atomic bomb dropped from a single plane would have required 220 B–29s carrying 1,200 tons of incendiary bombs, 400 tons of high-explosive bombs, and 500 tons of anti-personnel fragmentation bombs, if conventional weapons, rather than an atomic bomb, had been used. One hundred and twenty-five B–29s carrying 1,200 tons of bombs would have been required to

approximate the damage and casualties at Nagasaki. This estimate pre-supposed bombing under conditions similar to those existing when the atomic bombs were dropped and bombing accuracy equal to the average attained by the Twentieth Air Force during the last 3 months of the war.

As might be expected, the primary reaction of the populace to the bomb was fear, uncontrolled terror, strengthened by the sheer horror of the destruction and suffering witnessed and experienced by the survivors. Prior to the dropping of the atomic bombs, the people of the two cities had fewer misgivings about the war than people in other cities and their morale held up after it better than might have been expected. Twenty-nine percent of the survivors interrogated indicated that after the atomic bomb was dropped they were convinced that victory for Japan was impossible. Twenty-four percent stated that because of the bomb they felt personally unable to carry on with the war. Some 40 percent testified to various degrees of defeatism. A greater number (24 percent) expressed themselves as being impressed with the power and scientific skill which underlay the discovery and production of the atomic bomb than expressed anger at its use (20 percent). In many instances, the reaction was one of resignation.

The effect of the atomic bomb on the confidence of the Japanese civilian population outside the two cities was more restricted. This was in part due to the effect of distance, lack of understanding of the nature of atomic energy, and the impact of other demoralizing experiences. The role of the atomic bomb in the surrender must be considered along with all the other forces which bore upon that question with Japan.

Japan's Struggle to End the War

Japan's governmental structure was such that in practice the Emperor merely approved the decisions of his advisers. A consensus among the oligarchy of ruling factions at the top was required before any major question of national policy could be

decided. These factions, each of which had a different point of view, included the group around the Emperor of whom Marquis Kido, the Lord Keeper of the Privy Seal, was the most important, the ex-premiers constituting the Jushin or body of senior statesmen, and the cabinet. The Army and Navy named their own cabinet ministers, who, together with the two chiefs of staff, had direct access to the Emperor. The cabinet could perpetuate itself only so long as it was able to absorb or modify the views of the Army and Navy ministers, who, until the end, were strongly influenced by the fanaticism of the Army officers and many of the younger Navy officers. The ruling oligarchy considered the opinions of the Japanese people as only one among the many factors to be taken into consideration in determining national policy and in no sense as controlling.

The first definitive break in the political coalition which began the war occurred following our success at Saipan. Ten days thereafter, on 16 July 1944, the cabinet headed by General Tojo fell. This significant turn in the course of Japan's wartime politics was not merely the result of an immediate crisis. Even at that date, elements opposing continuation of the war had found means of applying pressure against the fanatic exponents of Japan's militaristic clique. The original factions who had either opposed war before Pearl Harbor, or gone along, or "retired" in the first phase of the conflict recognized as early as the spring of 1944 that Japan was facing ultimate defeat. By that time, United States determination to fight and her ability to mount overpowering offensives in the Pacific, even before the opening of the European Second Front, had already been demonstrated to many of those who had access to all the facts. The political problem of those who saw the situation was to circulate among other leaders in retirement or outside the government a true picture of the war and then unseat the Tojo government in favor of one which would bring the war to an end.

Rear Admiral Takagi of the Navy General Staff made a study between 20 September 1943 and February 1944, of the war's battle lessons up to that time. Based on analysis of air, fleet and merchant

ship losses, Japan's inability to import essential materials for production, and the potentiality of air attacks on the home islands, Takagi concluded that Japan could not win and should seek a compromise peace. His study and a similar one made by Sakomizu of the Cabinet Planning Board documented the fears of the Jushin, and through them of Marquis Kido, that all was not well with Tojo's prosecution of the war. With the loss of Saipan, it was possible to build up sufficient pressure to force Tojo's retirement.

The government of General Koiso, who was chosen by the ever-cautious Kido to head the succeeding cabinet, did not have the strength to stand up to the military and was a disappointment to the more enthusiastic peace makers. In spite of original instructions to give "fundamental reconsideration" to the problem of continuing the war, his only accomplishment in that direction was the creation of a Supreme War Direction Council, an inner cabinet which supplied the mechanism through which the problem of surrender was eventually resolved.

The conviction and strength of the peace party was increased by the continuing Japanese military defeats, and by Japan's helplessness in defending itself against the ever-growing weight of air attack on the home islands. On 7 April 1945, less than a week after United States landings on Okinawa, Koiso was removed and Marquis Kido installed Admiral Suzuki as premier. Kido testified to the Survey that, in his opinion, Suzuki alone had the deep conviction and personal courage to stand up to the military and bring the war to an end.

Early in May 1945, the Supreme War Direction Council began active discussion of ways and means to end the war, and talks were initiated with Soviet Russia seeking her intercession as mediator.

The talks by the Japanese ambassador in Moscow and with the Soviet ambassador in Tokyo did not make progress. On 20 June the Emperor, on his own initiative, called the six members of the Supreme War Direction Council to a conference and said it was necessary to have a plan to close the war at once, as well as a plan to defend the home islands. The timing of the Potsdam Conference interfered with a plan to send Prince Konoye to Moscow as a

special emissary with instructions from the cabinet to negotiate for peace on terms less than unconditional surrender, but with private instructions from the Emperor to secure peace at any price. Although the Supreme War Direction Council, in its deliberations on the Potsdam Declaration, was agreed on the advisability of ending the war, three of its members, the Prime Minister, the Foreign Minister and the Navy Minister, were prepared to accept unconditional surrender, while the other three, the Army Minister, and the Chiefs of Staff of both services, favored continued resistance unless certain mitigating conditions were obtained.

On 6 August the atomic bomb was dropped on Hiroshima, and on 9 August Russia entered the war. In the succeeding meetings of the Supreme War Direction Council, the differences of opinion previously existing as to the Potsdam terms persisted exactly as before. By using the urgency brought about through fear of further atomic bombing attacks, the Prime Minister found it possible to bring the Emperor directly in to the discussions of the Potsdam terms. Hirohito, acting as arbiter, resolved the conflict in favor of unconditional surrender.

The public admission of defeat by the responsible Japanese leaders, which constituted the political objective of the United States offensive begun in 1943, was thus secured prior to invasion and while Japan was still possessed of some 2,000,000 troops and over 9,000 planes in the home islands. Military defeats in the air, at sea and on the land, destruction of shipping by submarines and by air, and direct air attack with conventional as well as atomic bombs, all contributed to this accomplishment.

There is little point in attempting precisely to impute Japan's unconditional surrender to any one of the numerous causes which jointly and cumulatively were responsible for Japan's disaster. The time lapse between military impotence and political acceptance of the inevitable might have been shorter had the political structure of Japan permitted a more rapid and decisive determination of national policies. Nevertheless, it seems clear that, even without the atomic bombing attacks, air supremacy over Japan could have exerted

sufficient pressure to bring about unconditional surrender and obviate the need for invasion.

Based on a detailed investigation of all the facts, and supported by the testimony of the surviving Japanese leaders involved, it is the Survey's opinion that certainly prior to 31 December 1945, and in all probability prior to 1 November 1945, Japan would have surrendered even if the atomic bombs had not been dropped, even if Russia had not entered the war, and even if no invasion had been planned or contemplated.

Conclusion

The foregoing pages tell of the results achieved by air power in each of its several roles in the war in the Pacific, including the effects of the atomic bombs. The Survey has already reported on the results achieved by air power in the European war. It remains to seek out the degree to which the Pacific study modifies, adds to or supports the signposts to the future which were suggested by the European study; to state the extent to which hindsight suggests that air power might have been differently or better employed in the Pacific; to discuss the impact of the existence of atomic bombs on the role of air power; and to state the Survey's recommendations. First, however, it is necessary to point out some of the unique features of the Pacific war which must be borne in mind while considering lessons to be learned from it.

Uniqueness of Pacific War

The Pacific war was unique in many respects, as was the European war, and great reservation should be used in assuming that what was effective or not effective under those circumstances would be similarly effective at other times and under different circumstances. Japan's initial war strategy called for a war of limited objectives. Her capabilities did not permit an attack on our

basic supporting strength. She was, however, a fanatically determined enemy, well prepared initially, and the fighting equality of her soldiers, seamen and airmen should not be underestimated.

Japan's geographical situation determined that the Pacific war should in large measure be a war for control of the sea and to insure control of the sea, for control of the air over it. As a result, attacks against warships and merchant ships and amphibious operations for possession of island positions on which forward bases could be located were close to the heart of the struggle. Carrier task forces, surface ships to provide logistic support, and submarines therefore assumed roles of unusual importance.

Japan's industrial potential was approximately 10 percent of that of the United States. Even though her research and technical design work was not purely imitative, her ability to develop reliable operating equipment in the new fields was low. Her radar and communications equipment was weak. She could not build sufficient ships or escort vessels. She lacked construction equipment to build adequate airfields. She was always hampered by a lack of oil. Her antiaircraft was outmoded. She could not economically afford to build adequate shelters for her population. She could not both disperse her industry and also repair damaged plants. She chose dispersal rather than repair, but she had insufficient means even to disperse effectively.

Signposts

Not only the uniqueness of the Pacific war but new developments in weapons and tactics make it impossible to assert that signposts to the future derived from the Pacific war will apply with equal force to other situations. The Survey believes, however, that the following signposts as to the role of air power should be given thorough consideration by those working out the solutions to new problems arising under differing conditions.

1. Control of the air was essential to the success of every major military operation. Control of the air enabled surface vessels to sail

the seas as far as that control extended, even within range of enemy land-based airplanes. Control of the air permitted amphibious landings at any point where that control could be assured. Control of the air permitted close air support to ground forces, the effectiveness of which was decisive wherever fully employed. Control of the air over lines of communications permitted effective interdiction of them to the enemy and preserved them to ourselves. Control of the air over the Japanese home islands permitted the destruction by long-range bombing of such of her industries and cities as we chose to attack. The first objective of all commanders in the Pacific war, whether ground, sea or air, whether American, Allied, or Japanese, was to assure control of the air.

2. Control of the air was not easily achieved, and involved the coordinated application of all the resources of the nation. Air power consisted not merely of the planes and pilots that engaged the enemy, but of all the sources of strength that supported, reinforced and exploited control of the air. It was coordinanted team play of ground, sea and air forces, both ground-based and carrier-based, and their supporting services, backed up by the full effort of all phases of the home front that enabled us to secure control of the air, at first locally and then more generally, culminating in virtual freedom of the skies over the Japanese home islands themselves.

3. The limitations of air control deserve special mention. It was never completely possible to deny the air to the enemy. It was considered that we had control of the air when the enemy could not operate in it without prohibitive losses in relation to results achieved, while our own planes could operate in it at will and with acceptable risk of loss. The Japanese increased their ratio of results achieved to losses by adopting Kamikaze tactics. This was a measure of desperation, but the results obtained were considerable and, had they been much greater, might have caused us to withdraw or to modify our strategic plans. The principle involved indicates the degree to which defensive air control must be improved or enemy bases kept beyond the range of enemy suicide planes or guided missiles from such land or sea as we propose to use.

4. Given air control, there were also limitations as to the specific results which could be achieved in exploiting such control by aircraft carrying conventional high-explosive bombs. Fox holes, underground emplacements and other prepared defenses could not in many cases be reduced, and it was necessary to eliminate remaining ground forces in costly close-range fighting even though these forces were isolated and completely cut off from supplies and reinforcements.

Weather and darkness limited exploitation of air control, but as the war progressed technical and tactical advances were made which progressively reduced these limitations.

Combat radius of fighters and time on patrol at maximum radius, although great by previously existing standards, required that airfields or carriers be available within 300 nautical miles or less of the critical areas of surface combat for optimum fighter cover. The effective radius of our longest range bombers was limited to 1,500 miles and bases still closer to Japan were considered essential for emergency landing and fighter support.

The importance of reducing these limitations of control of the air and its exploitation by the application of research and development work in postwar years is obvious.

5. The experience of the Pacific war supports the findings of the Survey in Europe that heavy, sustained and accurate attack against carefully selected targets is required to produce decisive results when attacking an enemy's sustaining resources. It further supports the findings in Germany that no nation can long survive the free exploitation of air weapons over its homeland. For the future it is important fully to grasp the fact that enemy planes enjoying control of the sky over one's head can be as disastrous to one's country as its occupation by physical invasion.

Hindsight

Hindsight inevitably suggests that in some respects air power might have been differently or better employed.

Prior to the European war, we underestimated the predominant role that air power was to play and allocated to it too small a share of even the inadequate resources then available to the Army and Navy. At the outbreak of the Pacific war, our deficiency was particularly great in modern land-based fighters and in carriers. One thousand planes in the Philippines, at least equal in performance to the best then available to the Japanese, including types effective against shipping, well-manned, equipped and supplied, and dispersed on some 50 airfields, would have seriously impeded the original Japanese advance if knowledge of their existence had not entirely dissuaded the Japanese from making the attempt. The loss of relatively antiquated battleships at Pearl Harbor had little effect on the Navy's combat capabilities at that time, while the addition of a few carriers would have enormously increased its capabilities. Larger overall appropriations to the armed forces, beginning at the time of Japanese occupation of Manchuria when the threat to peace in the Far East became evident, might have made war unnecessary and would have paid for itself many times over in reduced casualties and expenditures had war still been unavoidable.

Upon entering the war, we were deficient not only in numbers, but in quality of many of our aircraft types. We were forced thereafter into hasty and costly modification and technical development programs to raise the performance of our aircraft to acceptable standards. These programs could have been conducted more efficiently and economically during prewar years.

In the actual conduct of the war we more quickly grasped the strategic revolution brought about by the capabilities of air power than did the Japanese. By the end of 1943 we had achieved through combat and the augmentation of our forces, such clear-cut superiority over the Japanese in all elements of air power that eventual victory was assured.

In exploiting this superiority greater economy of effort was possible. The structure of our prewar military organization provided no means, short of the President, for integrating our

armed forces. Under the pressure of war the Joint Chiefs of Staff was the most decisive mechanism then possible to fill this gap. Each of its members had in effect the power of veto and the required unanimity was produced by compromise. It proved impossible to agree on an overall commander for the Pacific as a whole. Our military and economic strength, however, made it possible to plan and execute a dual line of advance across the Pacific and to mount an air attack of sufficient weight to induce unconditional surrender concurrently with the preparation of a full scale invasion.

Capture of the Gilbert Islands produced limited strategic results. Attacks on Rabaul and other bypassed positions were continued longer and in greater volume than required. The effectiveness of high-level attack in softening up prepared defenses and in sinking maneuvering ships was overestimated. Prior to the occupation of the Marianas, B–29s could have been more effectively used in coordination with submarines for search, low-level attacks and mining in accelerating the destruction of Japanese shipping, or in destroying oil and metal plants in the southern areas, than in striking the Japanese ''Inner Zone'' from China bases.

In the final assault on the Japanese home islands we were handicapped by a lack of prewar economic intelligence. Greater economy of effort could have been attained, and much duplicative effort avoided, by extending and accelerating the strangulation of the Japanese economy already taking place as a result of prior attacks on shipping. This could have been done by an earlier commencement of the aerial mining program, concentration of carrier plane attacks in the last months of the war on Japan's remaining merchant shipping rather than on her already immobilized warships, and a coordinated B–29 and carrier attack on Japan's vulnerable railroad system beginning in April 1945.

We underestimated the ability of our air attack on Japan's home islands, coupled as it was with blockade and previous military defeats, to achieve unconditional surrender without invasion. By July 1945, the weight of our air attack had as yet reached only a fraction of its planned proportion, Japan's industrial potential had

been fatally reduced, her civilian population had lost its confidence in victory and was approaching the limit of its endurance, and her leaders, convinced of the inevitability of defeat, were preparing to accept surrender. The only remaining problem was the timing and terms of that surrender.

Having entered the war inadequately prepared, we continued all-out mobilization of all resources to bring ever increasing pressure on Japan, beyond the time when this was still reasonably required.

The Impact of Atomic Bombs on the Role of Air Power

Does the existence of atomic bombs invalidate all conclusions relative to air power based on preatomic experience? It is the Survey's opinion that many of the preexisting yardsticks are revolutionized, but that certain of the more basic principles and relationships remain. The atomic bomb, in its present state of development, raises the destructive power of a single bomber by a factor of somewhere between 50 and 250 times, depending upon the nature and size of the target. The capacity to destroy, given control of the air and an adequate supply of atomic bombs, is beyond question. Unless both of these conditions are met, however, any attempt to produce war-decisive results through atomic bombing may encounter problems similar to those encountered in conventional bombing.

The problem of control of the air, primarily of our own air, and should we be attacked, of the enemy's air as well, becomes of even greater significance. The most intense effort must be devoted to perfecting defensive air control both by day and night, through the improvement of early warning and fighter control apparatus, anti-aircraft ordnance and defensive fighters, not only from the standpoint of technological improvement and volume, but also of disposition and tactics. It would be rash, however, to predict an increase in the effectiveness of defensive control sufficient to insure that not a single enemy plane or guided missile will be able to

penetrate. It therefore behooves us to accept the possibility that at least a small number of enemy planes or guided missiles may be able to evade all our defenses and to attack any objective within range.

The threat of immediate retaliation with a striking force of our own should deter any aggressor from attacking.

If we are not to be overwhelmed out of hand, in the event we are nevertheless attacked, we must reduce materially our vulnerability to such attack. The experience of both the Pacific and European wars emphasizes the extent to which civilian and other forms of passive defense can reduce a country's vulnerability to air attack. Civilian injuries and fatalities can be reduced, by presently known techniques, to one-twentieth or less of the casualties which would be suffered were these techniques not employed. This does not involve moving everything underground, but does involve a progressive evacuation, dispersal, warning, air-raid shelter, and postraid emergency assistance program, the foundations for which can only be laid in peacetime. The analysis of the effects of the atomic bombs at Hiroshima and Nagasaki indicates that the above statement is just as true and much more terrifyingly significant in an age of atomic bombs than it was in an age of conventional weapons. Similarly, economic vulnerability can be enormously decreased by a well worked out program of stockpiles, dispersal and special construction of particularly significant segments of industry. Such a program in the economic field can also be worked out satisfactorily only in peacetime.

In the strictly military field the impact of atomic weapons and guided missiles on strategy and tactics can only be developed by military specialists. It is the Survey's opinion, however, that mature study by such specialists will support the conclusion that dispersal of military forces, and therefore space and distance in which to effect such dispersal, will be significant considerations; that heavy bombers similar to those used in this war will not be able to operate effectively and on a sustained basis much beyond the range of protective fighters, and that newer types of offensive

weapons and new tactics must be developed to do so; that forward air bases will have to be defended or more advanced bases acquired step by step in actual combat; and that the basic principles of war, when applied to include the field of the new weapons, will be found to remain. If such be the case, atomic weapons will not have eliminated the need for ground troops, for surface vessels, for air weapons, or for the full coordination among them, the supporting services and the civilian effort, but will have changed the context in which they are employed to such a degree that radically changed equipment, training and tactics will be required.

Recommendations

Over and above the numerous recommendations scattered throughout preceding sections of this report, of which the recommendation that we develop protection for our civilian population and for our economy is one of the most important, the Survey has been impressed with the need for concrete and prompt action to encourage adequate research and development; to assure adequate intelligence during peacetime; to integrate our military establishments; and to increase the national appreciation of the necessity for continued strength of the United States as a force for peace.

Research and development. The ''blitzkrieg'' technique is of enormous danger. This conclusion, derived initially from the European war, is strongly supported by the Japanese experience. A mobilized and well-trained striking force enjoying a certain technical superiority can overwhelm in short order the forces of a country of far greater basic long-term strength. In the opening phases of the Pacific war the Japanese were able to overrun 130,000,000 people and an area of enormous strategic importance in the space of a few months. This was true in spite of the fact that from the time of the Munich conference in 1938 we had been on

notice that aggression against the peace of the world was possible and that the intervening years and the experience of our Allies had been invaluable in permitting us to take the necessary steps to revise our strategic concepts, to apply our advanced scientific and development resources to the improvement of our weapons, and to begin our industrial and military mobilization. The distances of the Pacific fortunately gave us space, and therefore time, in which to absorb the initial blow while our increasing strength and Japan's increasing logistic problems reversed the initial disadvantages facing our advanced forces.

Science has increased tremendously the destructive capability of modern weapons and promises further developments in the future. Given an adequate supply of atomic bombs, the B–29s based in the Marianas had sufficient strength to have effectively destroyed in a single day every Japanese city with a population in excess of 30,000 people. In the future, national security will depend to a large degree on technical superiority of weapons and on operating and maintenance proficiency of personnel. Peacetime military strategic planning must be pointed to and supported by a vigorous program of scientific research and development.

If the United States is not to be forced to hasty and inadequate mobilization every time the threat of aggression arises in the world, it is essential that in the field of military weapons and tactics she be technically not merely abreast of, but actually ahead of any potential aggressor. It is not generally realized the degree to which basic scientific research was neglected in the United States during the course of the war in order to concentrate on the belated development of the specific weapons immediately required, nor the degree to which we lagged behind Germany in advanced aerodynamics, jet propulsion and the development of guided missiles. In air armament and torpedoes, even the Japanese were ahead of us. One or two years' lag in either basic research or in the development of reliable military application of such research can only be made up with difficulty, if at all. This type of work has become so complex that expenditures for research and development

in the order of one billion dollars annually may be required to assure an acceptable degree of national security.

Intelligence. At the start of the Pacific war our strategic intelligence was highly inadequate, and our overall war plans, insofar as they were based on faulty information and faulty interpretation of accurate information, were unrealistic. After Pearl Harbor the obtaining and analysis of economic and industrial information necessary to the planning of an attack on Japan's sustaining resources required several years of the most strenuous effort and even then substantial gaps remained. If a comparable lack of intelligence should exist at the start of a future national emergency, it might prove disastrous.

In the field of operational intelligence considerable forward strides were made during the Pacific war. The requirements in this field for a large volume of minutely detailed and accurate work, for complex analysis geared to rapidly changing capabilities of forces and weapons, and for speed, all place a heavy burden on training, competence and organization. These requirements were not fully met in the Pacific war; the deficiency was at times serious. This was in large measure traceable to a prewar lack of trained and competent operational intelligence officers to provide an adequate nucleus for an expanding organization.

The basis for adequate intelligence can only be laid in peacetime. The solution to our problems in this field appears in part to be the greater centralization to be provided by the National Intelligence Authority, particularly in securing more adequate coordination and dissemination. It appears also to lie in close integration into the various operating organizations of appropriate intelligence units, adequate budgets and personnel for intelligence work, and a sufficient increase in the prestige attached to such work to attract the highest quality of personnel. This latter can only come from increased training in intelligence and active appreciation of its functions on the part of other Army, Navy, and Government officials. The present lack of recognized responsibility for intelligence work by the various operating organizations and the

present shortage of trained and competent intelligence personnel give cause for alarm and require correction.

Integration of our military establishments. Organizational deficiencies in the Japanese Government contributed to Japan's entering a disastrous war and subsequently contributed to the absoluteness of her defeat. The form of her governmental organization provided no means for civilian control of the military or for obtaining effective coordination between the Army and Navy. Military policy was inconsistent with the foreign policy of the cabinet, the Japanese Army and Navy tending to make their own foreign policy in accordance with their individual aims, capabilities and requirements. During the war, bureaucratic rivalry between her Army and Navy impeded coordinated strategic and tactical planning, the proper employment of her air power, the development of adequate logistics and the efficient utilization of her economic resources. The existence of such joint or combined organizations as the Supreme War Council, the Supreme War Direction Council, the Board of Field Marshals and Fleet Admirals, the Imperial General Headquarters served mainly to hide the fact that real unity, integration, and coordination were conspicuously lacking.

Even though the United States did not achieve unity of command in the Pacific as a whole, each theater commander used the air, ground and sea forces assigned to him as an integrated or coordinated team. Coordination and compromise among theater commanders was largely achieved in all major respects. Such lack of complete integration as existed was in a large measure traceable back through the structure of the Joint Chiefs of Staff to the basic structure of our prewar military organization.

The Congress of the United States is today considering legislation for the reorganization and integration of our military establishments. The Survey is of the opinion that the prompt passage of appropriate legislation is in the national interest.

The lessons of the Pacific war strongly support that form of organization which provides unity of command, capable of clear

and effective decision at the top, strengthens civilian control and thus provides closer integration of military policy with foreign and domestic policy, and favors a high degree of coordination in planning, intelligence, and research and development. Such unity of command should, however, decentralize administrative burdens and permit specialized training and the free development of the component forces, even at the risk of some duplication.

Within a department of common defense which provides unity of command and is itself oriented toward air and new weapons, the Survey believes that, in addition to the Army and the Navy, there should be an equal and coordinate position for a third establishment. To this establishment should be given primary responsibility for passive and active defense against long range attack on our cities, industries and other sustaining resources; for strategic attack, whether by airplane or guided missile; and for all air units other than carrier air and such land-based air units as can be more effective as component parts of the Army or Navy. The mission of such a new establishment would differ considerably from that of an autonomous air force and would, in certain respects, require additional and broader experience than has heretofore been required by the Army air forces alone.

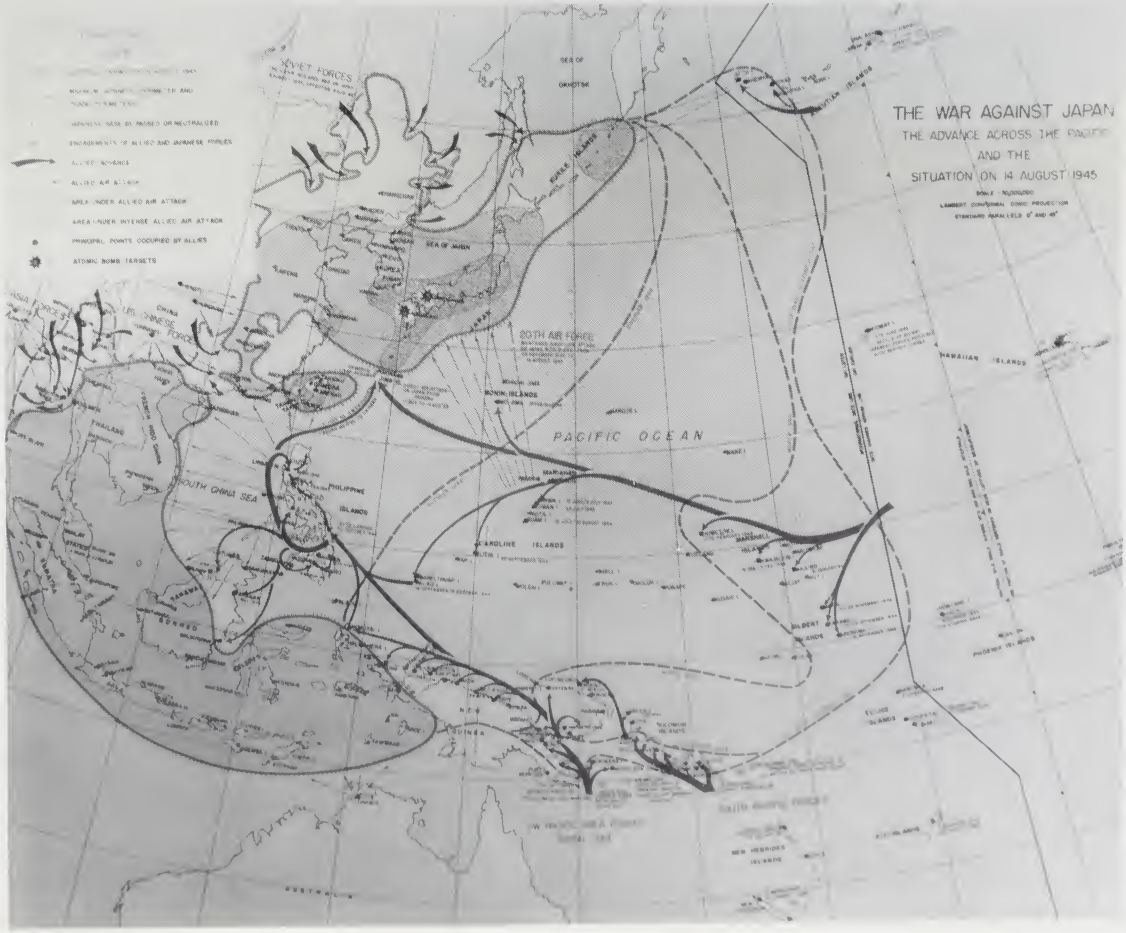
Strength as a force for peace. The Survey's report on the European war stated that the great lesson to be learned in the battered cities of England and the ruined cities of Germany is that the best way to win a war is to prevent it from occurring. This is fully supported by the example of the devastated cities of Japan and their unhappy and hungry surviving inhabitants. The prevention of war must be the ultimate end to which our best efforts are devoted. It has been suggested, and wisely so, that this objective is well served by insuring the strength and the security of the United States. The United States was founded and has since lived upon principles of tolerance, freedom and good will at home and abroad. Strength based on these principles is no threat to world peace. Prevention of war will not be furthered by neglect of strength or lack of foresight or alertness on our part. Those who contemplate

evil and aggression find encouragement in such neglect. Hitler relied heavily upon it. The Japanese would never have attacked Pearl Harbor had they not correctly assessed the weakness of our defenses in the Pacific and had they not incorrectly assessed the fighting determination of the United States when attacked.

Suggestions for assuring the military strength and security of the United States are by no means intended as a recommendation for a race in arms with other nations; nor do they reflect a lack of confidence in the prospect of international relationships founded upon mutual respect and good will which will themselves be a guarantee against future wars. The development of an intelligent and coordinated approach to American security can and should take place within the framework of the security organization of the United Nations.

The United States as a member of the United Nations has covenanted not to use force except in defense of law as embodied in the purposes and principles of the United Nations' Charter. As one of the great powers we must be prepared to act in defense of law and to do our share in assuring that other nations live up to their covenant.

The United States must have the will and the strength to be a force for peace.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